N05-A Pipeline & Spoolpiece – Basic Design

Basis of Design Pipeline & Tie-in Spools

DOCUMENT NUMBER:

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Client

ONE-Dyas B.V.

Project

ONE-Dyas N05A Pipeline & Spool piece – Basic Design

Document

Basis of Design Pipeline & Tie-in Spools

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Revision	Description
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1. Project Introduction

1.1. Project Introduction

ONEDyas plans to develop a successfully drilled well in block N05-A of the North Sea Dutch Continental Shelf. More wells will be drilled at this location through the jacket. It is planned to develop the wells by installing a platform and a gas export pipeline with a subsea connection to the NGT pipeline existing side tap connection @KP141.4. The approximate length of the pipeline is 14.6 km.

In addition, a power cable will be installed from the Riffgat Windpark to the N05-A platform.

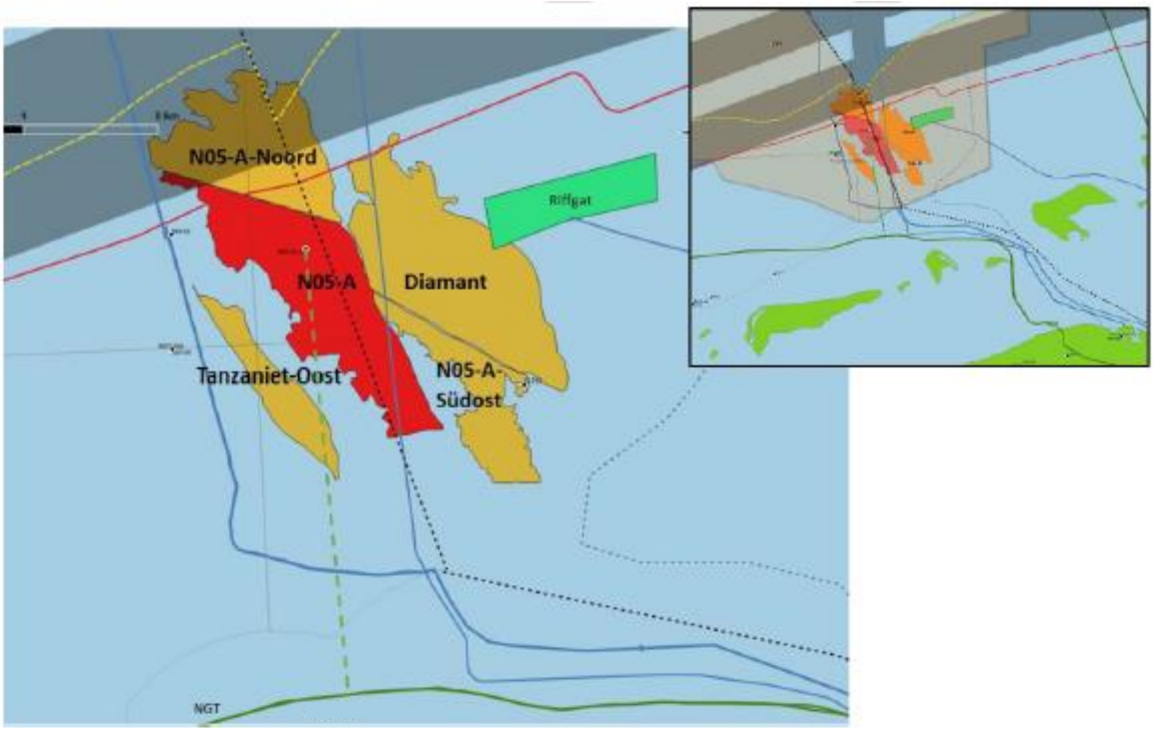


Figure 1: N05-A Field layout

1.2. Purpose Document

The Basis of Design defines the methodology and design data to be used throughout the flowline design from the new N05A platform to the connection to the NGT pipeline existing side tap @KP141.4. This document is to be read in conjunction with documents as listed below in order of precedence.

Number	Title
N05A-7-10-0-70026-01-01	N05-A Pipeline Design – Basis of Design Flow Assurance

The following engineering items are described in subsequent sections of this Basis of Design report:

- Regulations, Guidelines and Specifications
- Pipeline Routing
- Seabed Geology
- Materials and Corrosion Protection
- Operational and Product Data
- Environmental Data
- Design Philosophy & Criteria

1.3. System of Units

All dimensions and calculations shall be documented using the International System of Units (SI) unless noted otherwise.

1.4. Abbreviations

BoD	Basis of Design
CWC	Concrete Weight Coating
FEA	Finite Element Analysis
LAT	Lowest Astronomical Tide
MTO	Material Take Off
PUF	Poly Urethane Foam
TB	Target Box
TOP	Top of Pipe
VIV	Vortex Induced Vibrations

2. Regulations, Guidelines and Specifications

The references, codes, regulations, guidelines and specifications used throughout the project are outlined in the following sections.

2.1. Regulations, Codes, Standards and Guidelines

[1] NEN3656:2015 "Eisen voor stalen buisleidingsystemen op zee" December 2015

[2] DNV-OS-F101. "Submarine Pipeline Systems." October 2013.

[3] DNV-RP-F105. "Free Spanning Pipelines." June 2017.

[4] DNV RP-F107. "Risk Assessment of Pipeline Protection." May 2017.

[5] DNV-RP-F109. "On-Bottom Stability Design of Submarine Pipelines." May 2017.

[6] DNV-RP-F110. "Global Buckling of Submarine Pipelines. Structural Design due to High Temperature/High Pressure." April 2018.

[7] DNV-RP-C203. "Fatigue Design of Offshore Steel Structures." April 2016.

[8] -

[9] DNV-RP-F114. "Pipe-soil interaction for submarine pipelines." May 2017.

[10] 21. American Lifelines Alliance. "Guidelines for the Design of Buried Steel Pipe. ASCE July 2001.

[11] ASME Boiler and Pressure Vessel Code. Section VIII Rules for Construction of Pressure vessels. Division 1. July 2013.

[12] Design of Submarine Pipelines Against Upheaval Buckling OTC 6335 by A.C. Palmer e.a. May 1990

[13] ISO 15589-2. "Petroleum petrochemical and natural gas industries — Cathodic protection of pipeline transportation systems - Part 2: Offshore pipelines" 2nd edition - 2012

[14] NEN-EN 1993-1-8 – Design of Steel Structures

[15] NEN-EN-ISO 19902 – Fixed Steel Offshore Structures

[16] ASME N16.9-2001 – Factory made wrought buttwelding fittings

2.2. Project Reference Documents

[I] N5-1-10-0-10000-01, Statement of Requirements for Platform N05-A

[II] Metocean Criteria for the N05A Platform – 181892_1_R2

[III] Metocean Criteria for the N05A Platform Side Tap - 191146_1_R2

[IV] Pipeline Bathymetry: LU0022H-553_DR-007_PR_1-4_v1.0 / 2-4 / 3-4 / 4-4

[V] N05A-7-10-0-70018-01, N5A-Development-Pipeline Route and Platform Area Survey R1

[VI] N05A-7-10-0-70020-01, Environmental Baseline Survey Report 1.0

[VII] N05A-7-10-0-70027-01-03 Flow Assurance Design Report

[VIII] N05A-7-10-0-70036-01-01 Flow Assurance Design Report -transient analysis

[IX] N05A-7-10-0-70031-01-01 Route Selection Report

[X] LU0022H-553-RR-03-2.1 N5a Lab Test Results Report

[XI] N5A VC-C-7 S-3 0300m CID

[XII] N5A VC-P-3 S-2 0405m CID

[XIII] N5A VC-P-8 S-4 0240m CID

3. Design Parameters

This chapter describes the design data to be considered for the pipeline (incl. spool pieces near the riser and the side tap) from the new N05A-Platform to the NGT pipeline.

3.1. Pipe Data

The basic line pipe design and spool piece data to be considered in the analysis for the export gas line are presented in Table 3-1. Steel material properties considered in the design are presented in Table 3-2.

Property	
Product transported	Natural gas (dry)
Design life (years)	25
Approx. length (km)	14.6
Material grade	L360 NB
Manufacturing process	HFIW
Pipe outside diameter (")	20"
Pipe outside diameter (mm)	508
Pipe internal diameter	466.76
Wall thickness (mm)	20.62 (Sch60) TBC
Wall thickness tolerance (%)	7.3
Wall thickness tolerance (mm)	+/- 1.5mm
Internal corrosion allowance (mm)	3
Anti-corrosion coating	3LPP
Anti-corrosion coating thickness (mm)	3
Anti-corrosion coating density (kg/m^3)	930
(Concrete) weight coating thickness (mm)	t.b.d
concrete weight coating density (kg/m^3)	3300
Minimum hot bend radius (mm)	2540 (5D)

Table 3-1 Pipeline data

Property	
Material	L360NB
Density (kg/m3)	7850 kg/m^3
Specified Minimum Yield Strength at 20°C (MPa)	360
Specified Minimum Yield Strength at 50°C (MPa)	360
Specified Minimum Tensile Strength (MPa)	460
Young's modulus (Pa)	2.07×10^{11}
Poisson ratio (-)	0.3
Thermal expansion coefficient (m/m·ºC)	1.17×10^{-5}

Table 3-2 Material properties

3.2. Process conditions

Table 3-3 presents the pipeline and spool design process parameters considered in the analysis.

Property	Export gas line
Design pressure	111.1 bar(g)
Operating pressures	95 bar(g)
Design temperature (min / max)	-20 °C / 50 °C
Operating temperature (min / max)	1 / 43 °C
Ambient (air / surface) temperature	-6.8°C / +24.2 °C
Content density (arrival, nominal operation)	88.7 / 96.1 kg/m³
Design flowrate (min/max)	0.14 / 6.0 MMNm3/d

Table 3-3 Process design parameters

Figure 3-1 shows the operational thermal profile along the pipeline, ref. [vii] .

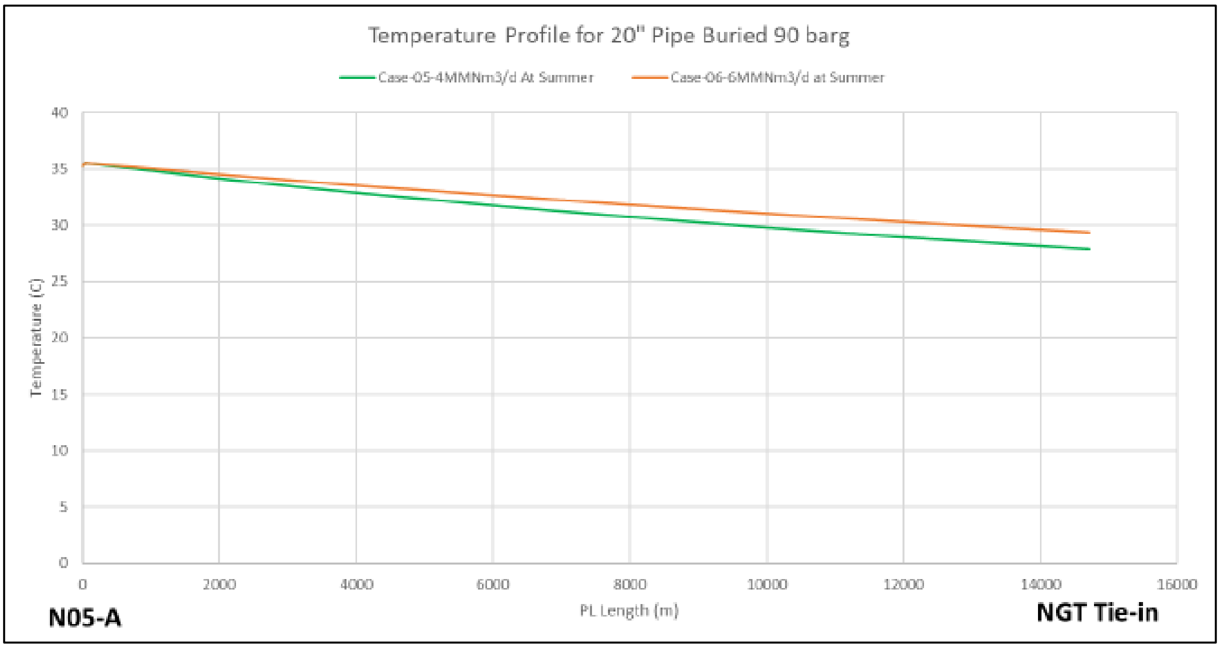


Figure 3-1 Operational thermal profile, nominal operation in summer

3.3. Coating Material Properties

Typical material properties of the coating are given in Table 3-4.

Property	Value
Anti-corrosion material type	3LPP
Anti-corrosion coating density	930 kg/m³
Anti-corrosion coating thermal conductivity	0.22 W/m°C
Anti-corrosion coating specific heat capacity	2000 J/kg°C

Table 3-4 Steel pipe coating material properties

3.4. Flange Properties

Table 3-5 presents the flange classes and main characteristics. The flange loads will be checked by using the ASME BPVC [10] flange integrity check. Note that table 3-5 is applicable to all flanges on the flowline and spool pieces.

Property	Export gas line
Flange rating	ANSI/ASME Class 1500
Flange type	RTJ Swivel / Weld Neck
Weld end thickness	20.62mm

Table 3-5 Flange properties

3.5. Environmental data

For the design of the pipeline, environmental data has been taken from Ref. [II] and [III]. Where Ref [II] contains the metocean data for the platform (water depth 26 m); Ref [III] contains the Metocean data for the NGT side tap tie-in (water depth 8 m) target box. Tables 3-6 to 3-11 present the relevant metocean data for the 1 and 100 year design conditions for the applicable locations.

Property	1-year return period	100-year return period
Positive surge (m) @26m	1.58	3.04
Negative surge (m)	-1.02	-1.79
LAT with respect to MSL (m)	-1.41	
HAT with respect to MSL (m)	1.31	

Table 3-6 Near platform extreme water level data [ref. II]

Return Period Depth Level	Extreme Cs [m/s] Direction [towards]								OMNI
	N	NE	E	SE	S	SW	W	NW	
1-year									
Near-surface	0.36	0.94	0.98	0.70	0.42	0.77	0.98	0.59	0.98
Mid-Depth	0.40	0.89	0.90	0.53	0.27	0.62	0.90	0.51	0.90
Near-bed	0.38	0.74	0.74	0.42	0.25	0.56	0.74	0.43	0.74
100-years									
Near-surface	0.46	1.21	1.27	0.91	0.55	1.00	1.27	0.76	1.27
Mid-Depth	0.51	1.15	1.16	0.68	0.35	0.79	1.16	0.66	1.16
Near-bed	0.49	0.95	0.96	0.55	0.32	0.72	0.96	0.55	0.96

Table 3-7- Near platform design current data [ref. II]

Return Period Direction [from]	Hs [m]	Tz [s]	Tp [s]	Cmax [m]	Hmax [m]	THmax [s]	U_{1m} [m/s]
1-year							
North	5.3	9.2	11.7	5.9	9.3	9.5	1.67
North-east	3.8	6.8	8.3	4.3	6.7	8.5	1.04
East	2.6	5.2	6.6	3.0	4.7	7.5	0.55
South-east	2.1	4.6	5.2	2.3	3.6	6.9	0.34
South	2.4	4.7	5.2	2.8	4.3	7.3	0.48
South-west	3.2	5.6	6.2	3.6	5.6	8.0	0.78
West	4.7	8.0	10.5	5.3	8.3	9.1	1.43
North-west	6.5	9.9	12.4	7.3	11.4	10.1	2.19
100-years							
North	8.1	11.5	14.3	9.1	13.8	10.8	2.73
North-east	5.9	8.1	10.4	6.6	10.0	9.7	1.84
East	4.0	5.9	8.2	4.5	6.9	8.6	1.07
South-east	3.1	4.9	6.0	3.5	5.4	7.9	0.71
South	3.7	5.0	6.0	4.2	6.4	8.4	0.95
South-west	4.9	6.4	7.3	5.5	8.3	9.1	1.43
West	7.2	9.8	12.9	8.1	12.3	10.4	2.40
North-west	9.9	12.3	14.9	11.1	16.9	11.5	3.20

Table 3-8 Near platform design wave data [ref. II]

Property	1-year return period	100-year return period
Positive surge (m) @26m	1.48	2.72
Negative surge (m)	-0.90	-1.26
LAT with respect to MSL (m)	-1.89	
HAT with respect to MSL (m)	1.61	

Table 3-9 Near tie-in extreme water level data [ref. III]

Return Period Depth Level	Extreme Cs [m/s] Direction [towards]								Omni
	N	NE	E	SE	S	SW	W	NW	
1-year									
Surface	0.31	0.52	1.04	0.51	0.27	0.50	1.04	0.59	1.04
Mid-depth	0.30	0.50	1.01	0.44	0.25	0.43	1.00	0.55	1.01
Near-bed	0.26	0.45	0.89	0.23	0.10	0.19	0.61	0.39	0.89
100-years									
Surface	0.37	0.63	1.25	0.62	0.32	0.60	1.25	0.71	1.25
Mid-depth	0.36	0.60	1.21	0.53	0.31	0.52	1.20	0.66	1.21
Near-bed	0.33	0.57	1.12	0.29	0.13	0.23	0.77	0.49	1.12

Table 3-10 Near side tap tie-in design current data [ref. III]

Return Period Direction [from]	Hs [m]	Tz [s]	Tp [s]	Cmax [m]	Hmax [m]	THmax [s]	U_{1m} [m/s]
1-year							
North	3.6	6.2	10.3	3.3	4.8	7.5	1.2
North-east	2.2	4.9	7.7	2.0	2.9	6.5	0.6
East	1.6	3.9	5.0	1.5	2.2	5.9	0.4
South-east	1.5	3.6	3.7	1.4	2.0	5.8	0.3
South	1.4	3.5	3.9	1.3	1.9	5.7	0.3
South-west	2.0	4.1	4.5	1.9	2.7	6.3	0.5
West	3.0	5.7	10.2	2.8	4.1	7.2	0.9
North-west	3.9	6.4	12.1	3.6	5.2	7.7	1.3
100-years							
North	3.9	6.4	10.6	4.2	5.7	7.9	1.5
North-east	2.4	5.1	7.9	2.6	3.5	6.8	0.8
East	1.7	4.1	5.2	1.9	2.6	6.2	0.5
South-east	1.6	3.7	3.8	1.8	2.4	6.1	0.4
South	1.6	3.7	4.1	1.7	2.3	6.0	0.4
South-west	2.2	4.3	4.6	2.4	3.2	6.7	0.7
West	3.3	6.0	10.7	3.6	4.9	7.5	1.2
North-west	4.2	6.6	12.6	4.5	6.2	8.1	1.6

Table 3-11 Near side tap tie-in design wave data [ref. III]

3.6. Marine growth

The following marine growth has been assumed, in accordance with NEN 3656 [1]

From	To	Thickness	Density
+2m LAT	Seabed	50mm	1300 kg/m3

Table 3-12 Assumed marine growth properties

3.7. Geotechnical data

The survey report – N5A to NGT side tap tie-in[ref. IV] indicates the soil along the route as 'fine to medium Sand, with occasional areas of coarse Sand and Clay with gravel and shell fragments. Three lab result reports [ref XI – XII] present the soil parameters for the sand in the trajectory. The soil properties are listed in Table 3-13, data has been taken from ref. X-XIII and recommended values as per NEN3656 table H.1 ref[1] based on the soil description as presented in [ref X]. A SBP data example of the north end of the proposed route is presented in figure 3-14.

Soil type	Applicable area	Submerged Unit Weight (kN/m³)	Angle of internal friction (°)
Medium sand (measured)		10.2-10.5	32.5-34.9
Medium sand	Pipe on surface	10	32.5
	Trench backfill	8.5	28
Rock dump	Crossing / Tie-in	10	40

Table 3-13 Assumed soil geotechnical properties

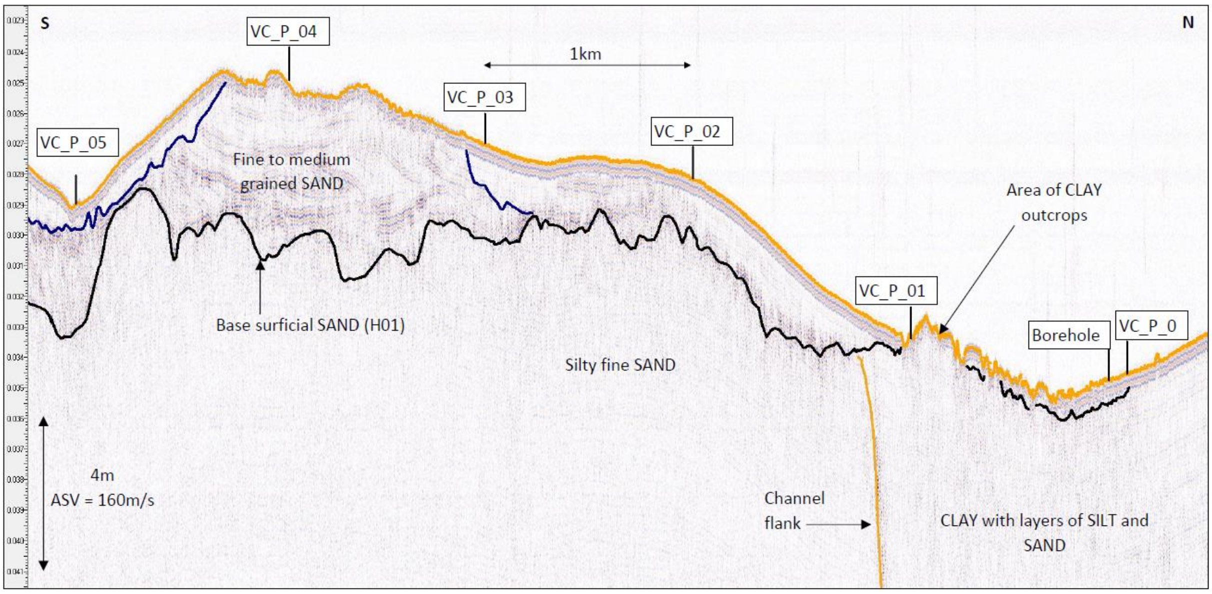


Figure 3-2 Soil profile from KP 0.0 to KP 6.0

4. Pipeline route data

This chapter deals with the pipeline route data describing the starting and end point of the pipeline, the used coordinate system, pipeline route coordinates and key facilities as well as the route bathymetry and contacts detected along the pipeline route. Based on this info the most optimal pipeline routing has been selected (ref. [IX].

4.1. General

The new pipeline to be installed originates at the new N05-A Platform and terminates at the NGT side tap via an existing connection. The pipeline length is approx. 14.6 km.

An installation of the pipeline on top of the seabed has been indicated as an opportunity. The final cover height or required concrete coating thickness will be determined based on the results of a risk assessment study, the on-bottom stability analysis and the upheaval buckling analysis.

Two pipeline/cable crossings are foreseen along the route. An overview of the field lay out is given in Figure 4-1.

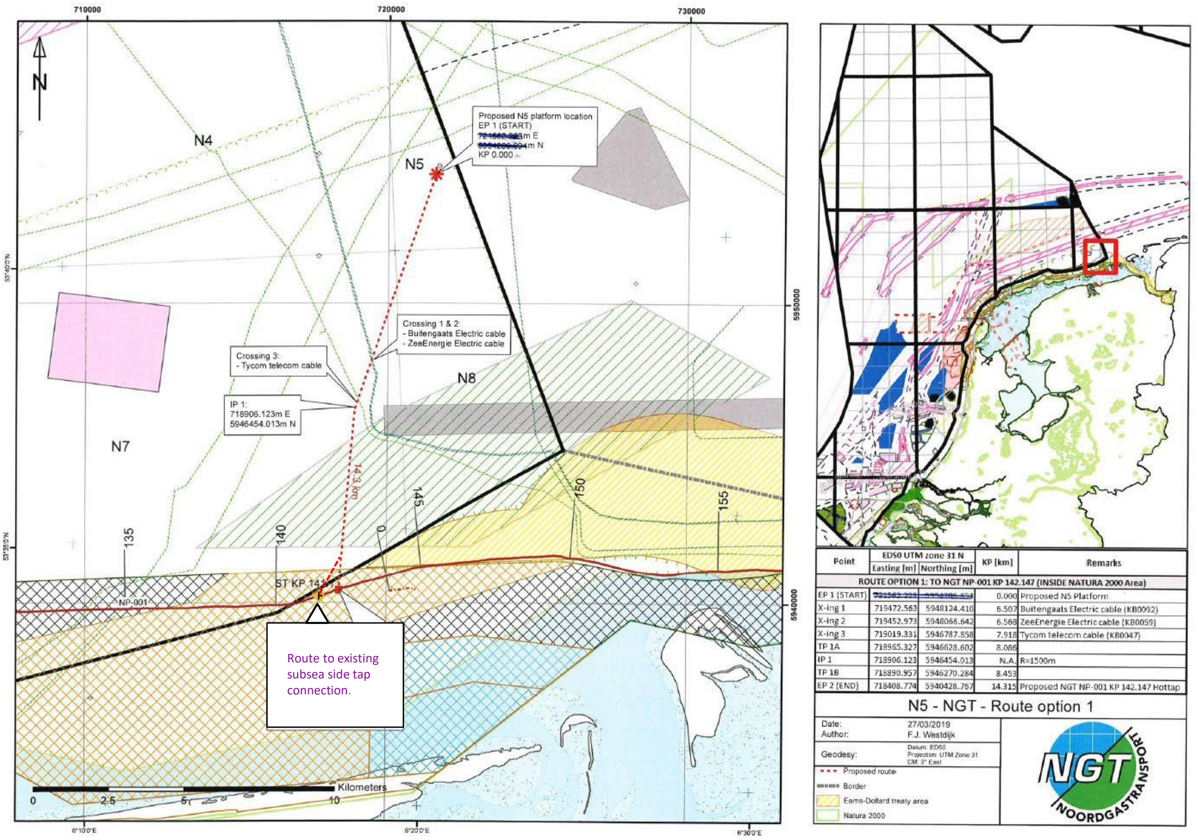


Figure 4-1 Overview N05A platform to the existing side tap tie-in location (left)

4.2. Coordinate system

The parameters of the geodetic system to be used for horizontal positions are listed in Table 4-1.

Item	Value
Datum	European Datum 1950 (ED50)
Projection	ED50 / UTM zone 31 N
Ellipsoid name	International 1924
Semi major axis	6 378 388 m
Inverse flattening	297.000
Central Meridian	03º00"00' E
Latitude of Origin	00º00"00' N
False Northing	0 mN
False Easting	500 000 mE
Scale Factor	0.9996

Table 4-1: Geodetic parameters

The vertical position is given relative to the Lowest Astronomical Tide (LAT).

4.3. Key facility coordinates

The following platform and tie in locations have been derived from Ref. [V] and are presented in Table 4-2.

Item	Northing (m)	Easting (m)
N05A Platform target box	5 953 858	721 896
NGT target box	5 940 213	717 687
NGT side tap location KP141.4	5 940 197	717 698
Water depth at N05A Platform	25.3 m LAT	
Water depth at NGT hot tap	9.8 m LAT	

Table 4-2 Key Facility coordinates

4.4. Bathymetry

Figure 4-3 shows the bathymetry along the surveyed flowline route. The water depths recorded during survey along the proposed N05-A platform and the NGT pipeline side tap location ranges between 9.8 m LAT and 25.3 m LAT.

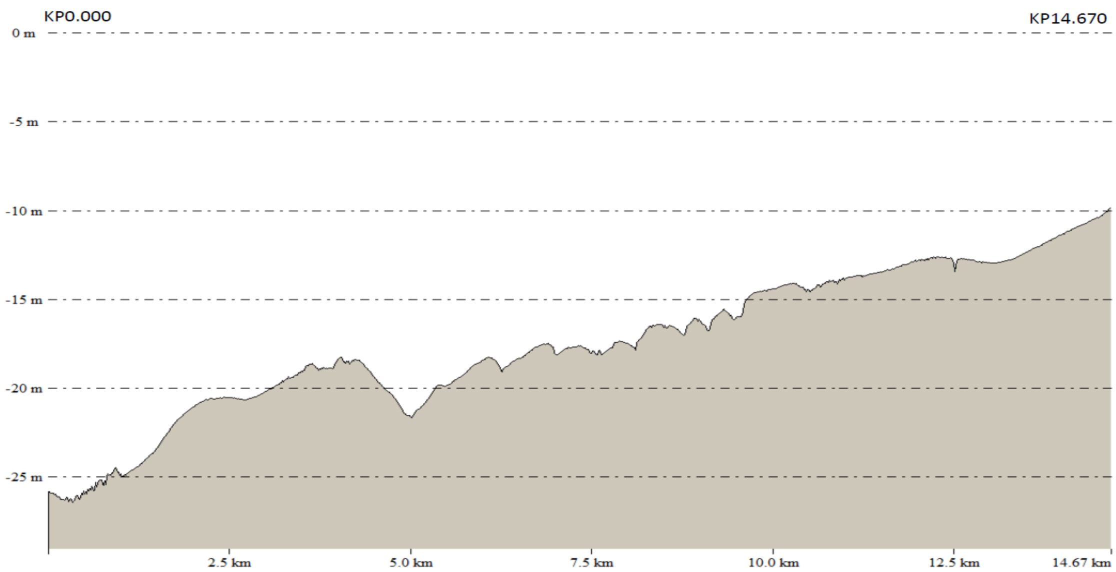


Figure 4-3 Seabed profile along pipeline route from N05-A Platform to NGT side tap connection

4.5. Side Scan Sonar Contacts & Magnetometer Anomalies

Ref. [5] describes the seafloor sediments across the N05-A to the proposed NGT side tap location survey area to consist of a top layer of fine to coarse sand, with occasional areas of coarse sand and clay with gravel and shell fragments. Photographs taken along the proposed route show the presence of small ripples covering the majority of the seabed within the survey corridor area.

Numerous boulders and items of debris are observed in the survey area. Most of the boulders occur in the north of the survey area and coincide with areas of clay exposure.

4.5.1. Magnetometer Contacts

A total of 241 magnetic anomalies (appendix A) were picked within the surveyed N05-A platform to the 36" NGT Tie-in and N05-A platform to Riffgat Tie-in route corridor. Most of these anomalies can be attributed to unknown identified seabed features the following seabed infrastructures are known, one (1) pipeline and four (4) cables. However, one (1) unknown linear feature.

The following existing pipelines and cables are detected:

- 36" Pipeline from L10-AR to Uithuizen
- Tycom Telecom cable
- Buitengaats Power cable
- Zeeenergie Power cable
- Norned Power cable

4.5.2. Geophysical Data

Eight-Hundred-Thirty (830) side scan sonar contacts were observed within the route survey. Most of the contacts are boulders located around the N05-A platform and stretching to the east side to Riffgat, besides the bolders the following contacts are found, twenty-six (26) debris items, two (2) wrecks. Side scan sonar data can be found in Appendix A.

4.6. Cable & Pipeline Crossings

The following crossings along the pipeline route are envisaged:

Infrastructure Name	KP	Northing (m)	Easting (m)
Buitengaats Electric cable	5.956	5.948.587	719.395
ZeeEnergie Electric cable	6.036	5.948.510	719.373
Tycom Telecom Cable Hunmanby GAP - Eemshaven	7.629	5.946.979	718.931

*) The N05A Pipeline will be connected to the NGT Pipeline with a side tap. This side tap is not part of the scope of the design report.

4.7. Approach

Near the platform a T-piece will be installed including 2 ball valves for the purpose of a future pipeline connection. At the NGT tie-in location 2 ball valves and a check valve will be placed for tie-in purposes. Figures 4-4 and 4-5 present an overview of respectively the platform and the tie-in location.

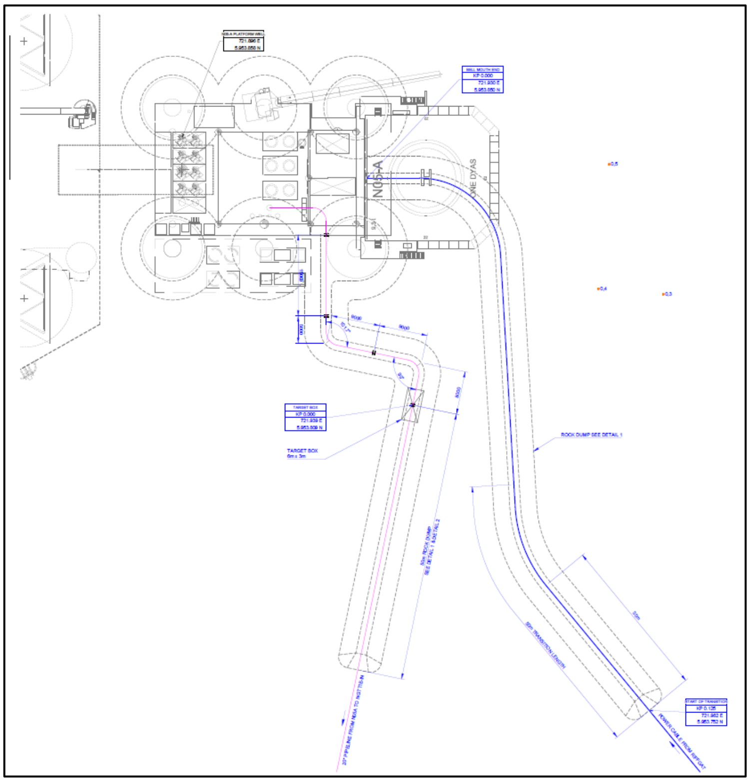


Figure 4-4 approach layout near the platform

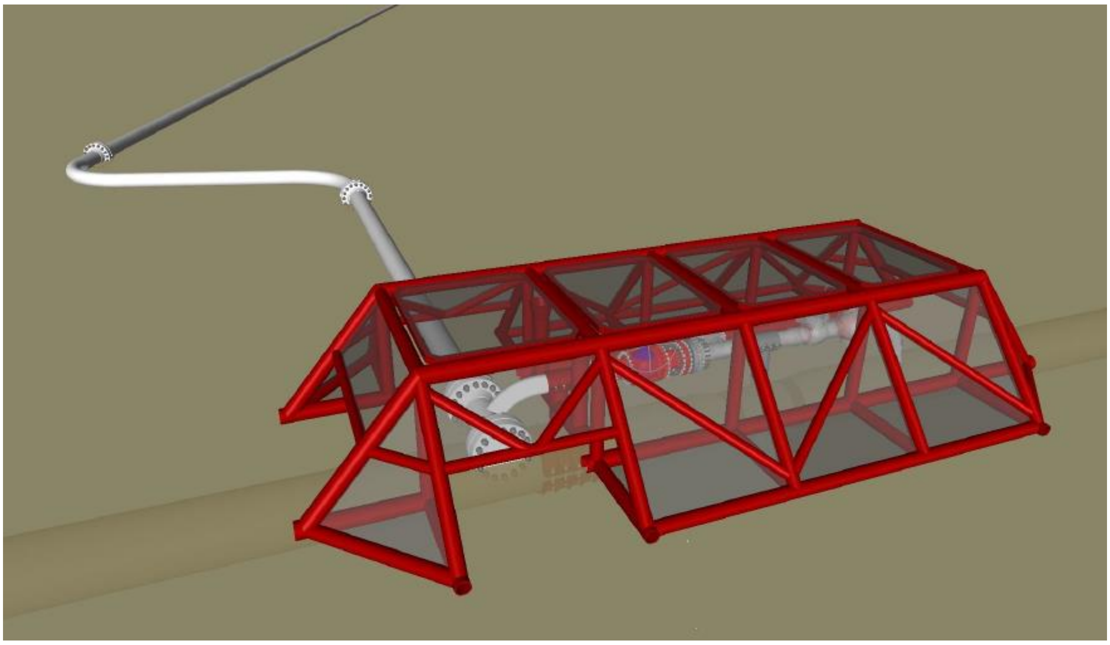


Figure 4-5 approach layout near the NGT Side tap tie-in

5. Riser and Spool piece analysis

The purpose of the riser and expansion spool analysis at the N05A platform is to determine the combined effect of functional and environmental loads on the structural integrity of the system. The analysis consists of the stress analysis of the spool pieces on both ends of the pipeline, carried out in accordance with NEN 3656:2015 (Nederlands Normalisatie-instituut, 2012).

5.1. Stress Criteria

Stresses in the riser and tie-in spool pieces will be assessed by using the finite element software ANSYS. The analysis ensures the structural integrity of the riser/spool system by NEN 3656 (Ref. [1])

The analysis will account for the load history of the pipe over the design life by considering the following four load cases:

- Installation
- Hydrotest
- Operational – Nominal
- Operational – Corroded

Considering the design cases listed above the following design loads will be considered when performing the stress analysis, see Table 5-1.

Load	Installation	Hydrotest	Operation
Pressure	N/A	Hydrotest Pressure	Design Pressure
Temperature	Seawater Temperature	Seawater Temperature	Design Temperature
Internal Fluid	Seawater	Seawater	Product Filled
Wall Thickness	Nominal	Nominal	Nominal / Fully corroded
Hydrodynamic Loads	1-year wave + 1-year current	1-year wave + 1-year current	100-year wave + 100 year current
Pipeline End Expansion	N/A	Expansion Under Hydrotest Pressure	Expansion under design temperature and pressure

Table 5-1 Design loads

Calculated equivalent stresses for the various design conditions will be checked against the allowable stress values, as per NEN3656 (Ref. [1]), see Table 5-2.

Case	Load Combination As Per NEN3656 Table 3.	Limit Stress	Allowable Equivalent Stress (LB360)
Installation	LC1	$R_{e(\theta)} / \gamma_m$	327 MPa
Hydrotest	LC4	$0.85\ (R_e + R_{e(\theta)})/\ \gamma_m$	556 MPa
Operation (Nominal / Corroded)	LC4	$0.85\ (R_e + R_{e(\theta)})/\ \gamma_m$	556 MPa

Table 5-2 Applied stress limits

Where:

Re = specified minimum yield strength at 20ºC (N/mm^2).

$R_{e(\theta)}$ = the yield strength of the material at design temperature.

γ_m = material factor (for steel 1.1).

All design loads applied will be factored as per the requirements of NEN 3656 (Ref. [1]), see Table 5-3.

Loads	Load factors for load combinations (a)								
Load combinations	LC 1	LC 2	LC 3	LC 4	LC 5	LC 6	LC 7a	LC 7b	LC 8
Internal pressure (design pressure)	-	1.25	-	-	-	-	1.0		1.0
Internal pressure (In combination)	-	-	-	1.15	1.15	-	-	1.0	1.15
Internal pressure (max. Incidental pressure)	-	1.10	-	-	-	-	-		1.1
Temperature differences (c g)	1.0	-	-	1.10	1.10	-	1.0	1.0	-
Soil parameters (d)	-	-	(d)	(d)	(d)	-	-	Low	-
Forced deformation (e)	-	-	1.1	1.1	1.1	1.1	-		-
Own weight	1.1	-	1.1	1.1	1.1	1.1	1.0		1.0
(Possible) coating (h)	1.2	-	1.2	1.2	1.2	1.2	1.0	1.2	1.0
Pipe contents (h)	1.1	-	1.1	1.1	1.1	1.1	1.0	1.1	1.0
Installation loads (f)	1.1	-	1.10	-	-	1.1	-		-
Hydrostatic pressure	1.1	-	1.1	1.1	1.1	1.1	1.0	1.1	
Marine growth (h)	-	-	1.2	1.2	1.1	-	1.0	1.0	1.0
Hydrodynamic forces	1.1	-	1.2	1.2	1.1	1.1	1.0	1.2	1.0

(a)	If a load has a favorable influence on the considered case this will not be considered if the load is variable and for a permanent load a multiplication factor of 0.9 is applied.
(b)	The maximum incidental pressure does not need to be checked separately however must be ascertained by the pressure control system.
(c)	During calculations of stress variations caused by temperature differences the highest and lowest occurring operation temperature should be considered. The displacements loads and moments exerting on connected equipment and/or structures are to be considered based on the design temperatures i.e. the temperature difference between the installation temperature and the maximum operational temperature.
(d)	Reference is made to ref. [1] – K.4 to determine load spreading factors
(e)	Forced deformations can be caused by: settling differences trench roughness execution sacking differences deformations due to prevented thermal expansion distortions in horizontal drilling and bottom-tow installation.
(f)	Examples of installation loads are those applied during pipelay tie-ins trenching landfalls and HDD etc.
(g)	Combined with measurements.
(h)	In the stability check (BC 7b) the most unfavorable combination must be chosen. If necessary divide by the relevant factor.

Table 5-3 Load factors

A description of the load combinations is shown below;

LC 1: Installation

LC 2: Only internal pressure, operating pressure, incidental pressure

LC 3: External load with zero internal pressure

LC 4: External load with internal pressure and temperature difference

LC 5: Variable load (primarily static load, e.g., temperature changes and pressure)

LC 6:a External pressure, external load and internal pressure zero

LC 7a: Incidental load (other than internal pressure)

LC 7b: Incidental load (meteorological)

LC 8: Dynamic loading

5.2. Model description

The riser and spool pieces will be modelled by using ANSYS dedicated submerged pipe element "PIPE59". This element is a uniaxial element with tension-compression, torsion, and bending capabilities and can account for internal pressure effects. The element is a 3D element with six degrees of freedom, translations in the x, y and z directions and rotations about the x, y and z axes. In addition the element accounts for buoyancy, wave and current loads, and is capable of large deflections and rotations.

Hot bends are modelled by using "PIPE18" elements which are elastic bend pipe elements with similar properties as the straight "PIPE59" elements described previously.

At riser clamp locations pipe nodal translation and/or rotations shall be constrained appropriately based on the physical constraints provided by the clamps (guide clamps / anchor clamps).

To incorporate pipeline end expansion into the spool pieces a representative pipeline length (greater than the anchor length) will be modelled. Note that conservatively seabed undulations are neglected while modelling these pipeline sections as this provides the greatest end expansion into the spool pieces.

Pipe-soil interaction is simulated using three independent non-linear spring elements (COMBIN39) attached to each pipe element. The springs represent the soil frictional resistance in the axial and lateral directions and the soils bearing capacity in the vertical direction. As the spool piece will be rock dumped after the hydrostatic testing, additional non-linear springs representing the uplift resistance of the rockdump / trenched backfill material, are attached to the pipe elements for the "operational" load cases. A detailed description of how the pipe soil interaction will be modelled is provided separately in section 5.3.

5.3. Pipe-soil interaction

The characteristics of the springs, which simulated the pipe-soil interaction, are defined through non-linear force-deflection curves. The force-deflection curves describe the frictional restraint provided by the soil to the pipeline in the axial and lateral direction and the soil's bearing capacity / upwards resistance in the vertical direction. The upcoming sections describe how the force-deflection curves of the springs are generated.

5.3.1. Exposed pipeline – axial soil resistance

The axial soil resistance for a pipeline / spool piece resting on the seabed, per meter pipe-length, is a function of the pipe submerged weight (vertical load) and the axial Coulomb friction coefficient. The axial friction is determined as follows:

$$F_{axial} = \mu_{Coulomb} w_s$$

Where:

- F_{axial} = Peak axial soil resistance [N/m]
- $\mu_{Coulomb}$ = Coulomb friction coefficient [-]
- w_s = Pipe submerged weight [N/m]

The axial restraint will be described through a bi-linear force-displacement relationship, as shown in Figure 5-1. The stiffness of the springs varies along the pipeline route and between load steps to account for variations in the pipe submerged weight and soil conditions.

The axial spring mobilization displacement is assumed to be 1.25 mm.

Figure 5-1 Axial resistance Force-Displacement curve

5.3.2. Exposed pipeline – lateral soil resistance

Lateral soil resistance is composed of two parts:

- Coulomb friction.
- Passive soil resistance due to the build-up of soil penetration (and hence a soil berm, as the pipe moves laterally).

To account for both components of resistance, an equivalent friction coefficient shall be used, which is defined as:

$$\mu_{equivalent} = \mu_{Coulomb} + \mu_{passive}$$

Where:

- μ_{eqv} = Equivalent lateral friction coefficient [-]
- $\mu_{Coulomb}$ = Coulomb friction coefficient [-]
- $\mu_{passive}$ = Passive soil resistance coefficient [-]

The passive soil resistance model proposed in DNV's Recommended Practice, DNV-RP-F109 (rev. [5]) will be used.

The passive soil resistance coefficient, for a pipeline resting on a sandy seabed, depends on the pipe penetration depth into the soil and can be determined by the formulation:

- $\mu_{passive} = \frac{F_R}{F_C} = (5\kappa_s - 0.15{\kappa_s}^2)\left(\frac{z_p}{D}\right)^{1.25}$ if $\kappa_s \leq 26.7$
- $\mu_{passive} = \frac{F_R}{F_C} = \kappa_s \left(\frac{z_p}{D}\right)^{1.25}$ if $\kappa_s > 26.7$

Where:

- F_R = Passive resistance force [N/m]
- F_C = Vertical contact force between pipe and soil [N/m]
- D = Pipe outside diameter, including all coatings [m]
- z_p = Total pipe penetration [m]
- κ_s = Soil parameter for sandy soils [-]
- γ'_s = Submerged unit soil weight [N/m^3]

The soil parameter for sand, κ_s, is determined as:

$$\kappa_s = \frac{\gamma'_s D^2}{F_C}$$

The total pipe penetration is taken as the sum of:

- Initial penetration due to self-weight.
- Penetration due to dynamics during laying.
- Penetration due to pipe movement under the action of waves and current.

The pipe static/initial penetration due to self-weight for pipelines resting on sandy soil will be determined using the following formula taken from DNV-RP-F109 (rev. [5]):

$$\frac{z_{pi}}{D} = 0.037\kappa_s{}^{-0.67}$$

Just as for the axial restraint, the lateral soil resistance will be described through a bi-linear force-displacement relationship as presented in Figure 5-1. The friction forces are increased monotonically to a maximum value calculated as the product of the pipe submerged weight (w_s) and the equivalent friction coefficient (μ_{eqv}), at a mobilisation distance of 2mm.

5.3.3. Vertical soil bearing capacity (Downward resistance)

The static vertical soil reaction per unit length can be determined based on bearing capacity formulas for ideal 2-D strip foundations, as per DNV-RP-F105 (rev. [3]):

$$R_V = \gamma'_{soil} B(N_q v_{eff} + 0.5 N_\gamma B)$$

Where:

- R_V = Vertical soil reaction [N/m]
- N_q & N_γ = Bearing capacity factors [-]
- v_{eff} = Effective penetration [m] (The larger of $v - D/4$ and 0)
- v = Vertical penetration [m]
- B = Contact width for pipe-soil load transfer [m]

The bearing capacity factors are determined as follows:

$$N_q = e^{\pi \tan\varphi_s} \tan^2\left(45 + \frac{\varphi_s}{2}\right)$$

Where:

φ_s = Angle of internal friction [°]

$N_\gamma = 1.5(N_q - 1)\tan\varphi_s$

The contact width for pipe-soil load transfer, B, is given by:

- $B = 2\sqrt{(D - v)v}$ if $v \le D/2$
- $B = D$ if $v > D/2$

5.3.4. Buried pipeline – axial soil resistance

Soil resistance forces for buried pipeline sections are based on ASCE's "Guidelines for the Design of Buried Steel Pipe" [9].

The maximum axial soil force that can be transmitted to the pipe per unit length is given by:

$$T_u = \pi D \alpha c + \pi D H {\gamma'}_s \frac{1 + K_0}{2} \tan \delta$$

Where:

- c = Soil cohesion representative of soil backfill material [N/m^2] (c=0 for sand)
- H = Depth to the pipeline centreline [m]
- K_0 = Coefficient of earth pressure at rest [-] $(1 - \sin \varphi_s)$
- α = Adhesion factor [-]
- δ = Interface angle of friction for pipe and soil [°] $(f \varphi_s)$
- f = Coating dependent factor relating the internal friction angle of the soil to the friction angle at the pipe soil interface.

The axial resistance mobilisation displacement, Δ_t, is determined considering the soil type as follows:

- Δ_t = 3mm for dense sand
- Δ_t = 5mm for loose sand
- Δ_t = 8mm for stiff clay
- Δ_t = 10mm for soft sand

5.3.5. Buried pipeline – lateral soil resistance

The maximum lateral force that the soil can transmit per unit pipe length is given by:

$$P_u = N_{ch}cD + N_{qh}\gamma'_s HD$$

Where:

- N_{ch} = Horizontal bearing capacity for clay (0 for c=0).
- N_{qh} = Horizontal bearing capacity factor for sand (0 for $\varphi_s = 0$)

The bearing capacity factors are taken from figure 5-2

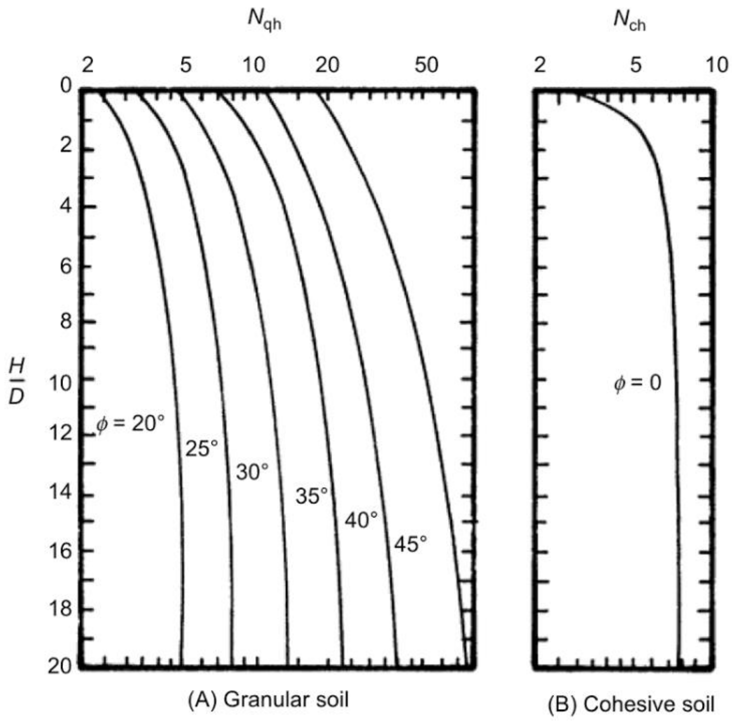


Figure 5-2 Horizontal bearing capacity factors

The lateral soil resistance mobilization displacement is given by:

$$\Delta_p = 0.04\left(H + \frac{D}{2}\right) \leq 0.10D \ to \ 0.15D.$$

5.3.6. Buried pipeline – vertical upward soil resistance

The uplift resistance R_{max} of a pipe in sand consists of two components, viz. a component owing to the weight of the soil above the pipe and a component owing to soil friction as per DNV-RP-F110 (rev. [6]). The uplift resistance can therefore be expressed as:

$$R_{max} = \left(1 + f\frac{H}{D}\right)(\gamma'_s HD)$$

The uplift resistance factor, f, is:

- $f = 0.1$ for loose sand (backfill)
- $f = 0.5$ for rockdump

The non-linear force-displacement response of a buried pipe is represented by a tri-linear curve as shown in figure 5-3.

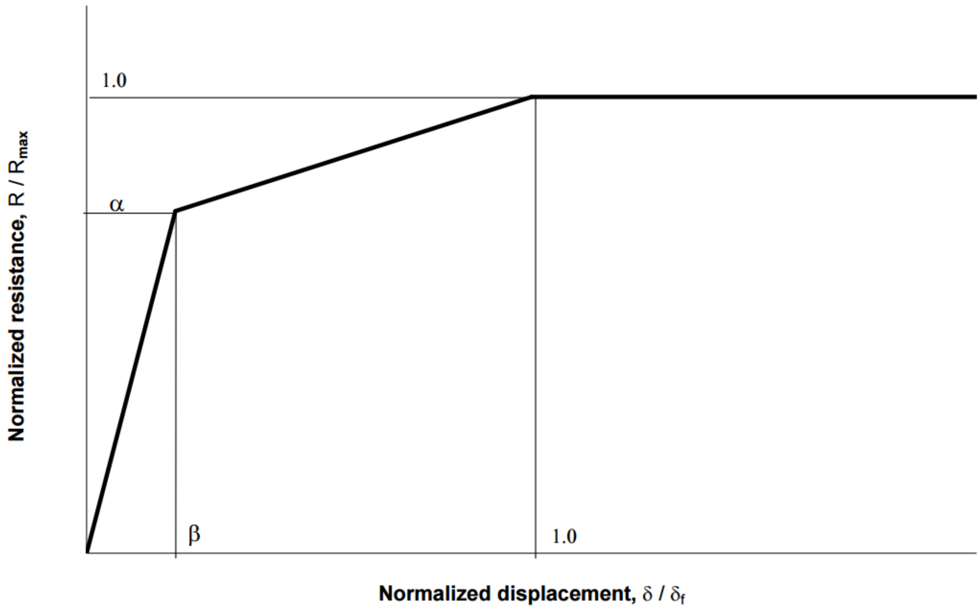


Figure 5-3 Uplift resistance Force-Deflection curve

Where:

- δ_f = Failure displacement (=0.0065H for loose sand backfill) (=20mm for rock dump)
- $\alpha = 0.8$ for loose sand (backfill) and $\alpha = 0.7$ for rock dump
- $\beta = 0.2$

5.4. Fatigue analysis

Fatigue is caused by time varying stresses resulting from applied loads to the riser and parts of the spool piece system which are exposed to hydrodynamic loads.

The riser and spool piece section are from approx. LAT +6.000m to seabed level exposed to the environment and hence are subjected to time varying loads. Three sources of time varying loads, and hence fatigue damage to the riser, are identified:

1. Vortex Induced Vibrations (VIV)
2. Direct wave loading
3. Indirect loads resulting from platform deflections

Riser guide clamps will be spaced such that the maximum span length is below the critical span length at which VIV can occur. The methodology for determining the critical span lengths are described in chapter 7 of this report.

To assess fatigue damage due to direct and indirect wave loading, platform deflections are applied, and the exposed riser section will be subjected to hydrodynamic drag and inertia forces. The drag and inertia forces are determined using the wave induced velocities and accelerations as experienced by the riser section over the lifetime of the pipeline system considering the "Individual Wave Scatter Diagrams for Fatigue H-T" attached as appendix B.

To estimate the fatigue damage, due to direct and indirect wave loading, a detailed finite element assessment will be carried out considering the same finite element model of the riser spool system as described in Section 5.

In this case the H-T wave scatter diagram will be subdivided into a number of representative blocks, with a single sea-state selected to represent all waves in that block. For the wave height within a particular bin the mean wave height is selected and the corresponding wave period is based on the weighted average of the mean wave periods. This reduces the number of required finite element analyses. These wave blocks and the corresponding platform deflections based on the actual platform deflections will be applied to the model. The analyses will account for the directionality of the wave and the number of occurrences of the waves as per the scatter diagrams. The maximum longitudinal (= axial + bending) stress ranges are extracted from the riser elements as follows:

$$\Delta\sigma_{ax,max} = \Delta\sigma_{ax,pdeflect} + \Delta\sigma_{ax,wave} = 2 * \sigma_{ax,amplitude,pdeflect} + (\sigma_{ax,max,wave} - \sigma_{ax,min,wave})$$

Where:

- $\Delta\sigma_{ax,pdeflect}$ = Longitudinal stress range due to platform deflection [N/m^2]
- $\Delta\sigma_{ax,wave}$ = Longitudinal stress range due to wave [N/m^2]
- $\sigma_{ax,amplitude,pdeflect}$ = Single longitudinal stress amplitude due to platform deflection [N/m^2]
- $\sigma_{ax,max,wave}$ = Maximum longitudinal stress due to wave [N/m^2]
- $\sigma_{ax,min,wave}$ = Minimum longitudinal stress due to wave [N/m^2]

The allowable number of cycles will then be determined (N_p) in relation to the maximum longitudinal stress range in all riser elements ($\Delta\sigma_{ax,max}$) for each wave block given by:

$$\log N_p = \log a_n - m_n \log\left(\Delta\sigma_{ax,max}\left(t/t_{ref}\right)^k\right)$$

Where:

- N_p = Predicted number of cycles of failure for stress range [-]
- $\Delta\sigma_{eqv,max}$ = maximum stress range [N/m^2]
- $\log a_n$ = Constant valid in the range n (see Table 5-4)
- m_n = Constant valid in the range n (see Table 5-4)
- t = Wall thickness [m]
- t_{ref} = Reference wall thickness (16mm)
- k = Thickness component (see Table 5-4)

S-N curve designation	N<=10^6 cycles		N>10^6 cycles		Fatigue limit at 10^7 cycles	Thickness component (k)
	m_1	log(a_1)	m_2	log(a_2)		
F (seawater with cathodic protection)	3.0	11.455	5.0	15.091	41.52	0.00

Table 5-4. Fatigue curve parameters (ref. [6])

The design S-N curve (F-curve) is selected according to Table 2.5 of DNV-RP-C203, Ref [7] based on the expected maximum misalignment δ_m, see equation 2.10.5 of Ref [7]. The expected misalignment is calculated based on the pipe diameter/wall thickness and pipe tolerances (thickness and diameter) as given in Table 3.1.

The Stress Concentration Factor (SCF), to be used in the fatigue calculations for both the corroded and non-corroded wall thickness case, is shown in Table 5.5. They are calculated based on equations 2.10.4 and 2.10.1 of DNV-RP-C203, Ref [7].

Pipeline	Case	δ_m (mm)	SCF
20" Export Gas	Non corroded	2.12	1.25
20" Export Gas	Corroded	2.12	1.29

Table 5-5. Overview SCFs

The total fatigue damage due to direct wave loading and platform deflections is then determined, through summation using the Palmgren-Miner rule at each element in the riser as follows:

$$FD = \sum_{1}^{k}\left(\frac{n_i}{N_i}\right)$$

Where:

- k = Number of stress/wave blocks
- n_i = Number of stress cycles/wave occurrences in stress block i
- N_i = Number of cycles to failure at constant stress range in stress block i

The acceptability of the fatigue damage is then determined by comparison with the allowable fatigue damage (α_{fat}) ratio as given in Ref. [2]:

$$\alpha_{fat} \geq FD$$

Where:

α_{fat} = Allowable damage ratio = 0.1 [2]

5.5. Low cycle analysis

The riser and spool piece system will also be checked for low cycle fatigue, i.e. stress variations due to pressure and temperature fluctuations. During the pipeline's lifetime the following pressure/temperature fluctuations are anticipated:

- 1x strength test
- 3x leak tests (worst case)
- 25x shut down: Dp = 75 barg and temperature to ambient (annual shut down)

The allowable cycles for the resulting stress variations are to be determined from figure K.8 of ref. [1].

6. Wall Thickness Analysis

Several phenomena are to be investigated prior to finalising the selected wall thickness. Elements to be taken into account:

- pressure containment;
- on-bottom stability;
- implosion;
- progressive plastic collapse;
- local buckling;
- bar buckling;

6.1. Pressure containment

6.1.1. Design condition

NEN 3656, states that for every load combination the design resistance (R_d) must be greater than or equal to the loading effect (S_d) or:

$$R_d \geq S_d$$

R_d is defined as:

$$R_d = R_{e(\Theta)} / \gamma_m$$

Where:

$R_{e(\Theta)}$	=	yield strength of the material at design temperature (N/mm^2)
γ_m	=	material factor (1.1 for steel)

For load combination LC2 (internal pressure only), the equation for hoop stress can be expressed as:

$$\sigma_h = \frac{\gamma_p \cdot P_d \cdot (OD - t_{\min})}{2 \cdot t_{\min}}$$

Where:

s_h	=	hoop stress (N/mm^2)
γ_p	=	load factor as per Table 5-3 (-) => 1.25
Pd	=	design pressure (N/mm^2)
OD	=	outside diameter of steel pipe (mm)
t_{min}	=	minimum wall thickness (mm)

The selected wall thickness (t_{nom}) is then determined by:

$$t_{nom} = \left\{ \frac{t_{\min} + CA}{1 - f_{tol}} \right\}$$

Where:

CA	=	applicable corrosion Allowance (mm)
f_{tol}	=	fabrication tolerance (%)

Further to this, NEN 3656 specifies additional requirements for bends with a bending radius R_b < 10 OD, to adjust the hoop stress of straight pipe (torus effect).

$$S_h(bi) = \frac{2R_b - \frac{1}{2}OD}{2R_b - OD} \cdot S_h \quad \text{(for inside bend)}$$

$$S_h(bo) = \frac{2R_b + \frac{1}{2}OD}{2R_b + OD} \cdot S_h \quad \text{(for outside bend)}$$

6.1.2. Hydrostatic Testing

The hydrostatic testing of pipeline / riser systems has two objectives:

- verify the strength of the system
- verify that there are no leaks from the system

The test pressure, P_t, will be determined as per as per Section 10.18.3 of NEN 3656 (Ref. [1]).

$$P_{t.\min} = C_p \cdot P_d \cdot \frac{R_e}{R_{ev}}$$

Where:

C_p	=	pressure test coefficient (-) => 1.30 for gas lines; 1.25 for others
P_d	=	design operating pressure (N/mm^2)
R_e	=	minimum yield stress at 20 °C (N/mm^2)
R_{ev}	=	minimum yield stress at design temperature (N/mm^2)

The maximum hydrostatic test pressure is based on the weakest part of the pipeline/riser system to be tested. The pressure shall not exceed, $P_{t,max}$, which is defined by:

$$P_{t.\max} = \frac{2.R_e \cdot t_{\min}}{(OD - t_{\min})}$$

However, the maximum hydrotest pressure should not exceed the mill test pressure, which is given by:

$$P_{T,mill} = 0.9 \cdot \frac{2 \cdot R_e \cdot t_{nom}}{OD} \quad \text{and}$$

$$t_{nom} = \left\{ \frac{t_{\min} + CA}{1 - f_{tol}} \right\}$$

Where:

t_{nom}	=	nominal wall thickness (mm)
t_{min}	=	minimum wall thickness (mm)
CA	=	applicable corrosion Allowance (mm)
f_{tol}	=	fabrication tolerance (%)

6.2. On-bottom Stability

6.2.1. Introduction

The aim of the stability analysis is to verify that the submerged weight of the pipeline ensures lateral stability against environmental loading. Depending on the pipeline being buried or not, the on-bottom stability analysis is carried out for the following condition(s):

- Installation – flooded
- Installation – empty
- Operation – product filled

The pipeline is to be laterally stable on the seabed for a 1 year resp. 100 year return period environmental conditions for a buried resp. unburied pipe. A buried pipeline will not be subject to any environmental loading during hydrostatic testing and operation.

6.2.2. Hydrodynamic loads

Hydrodynamic loads arise from the relative motions between pipe and seawater. They consist of drag, lift and inertia forces.

The drag force F_D is given by:

$$F_D = C_D \cdot OD_{tot} \cdot \frac{1}{2} \cdot \rho \cdot V \cdot |V|$$

Where:

C_D	=	drag force coefficient (-)
OD_{tot}	=	total diameter of coated pipe (m)
ρ	=	mass density of surrounding fluid (kg/m^3)
V	=	velocity of the fluid normal to the pipe axis (m/s)

The lift force F_L is calculated by the following equation:

$$F_L = C_L \cdot OD_{tot} \cdot \frac{1}{2} \cdot \rho \cdot V^2$$

Where:

C_L	=	lift force coefficient (-)

The inertia force F_I is determined by the following equation:

$$F_I = \rho \cdot C_I \cdot \frac{\pi}{4} \cdot OD_{tot}^{\,2} \cdot a$$

Where:

C_I	=	inertia force coefficient (-)
a	=	Fluid particle acceleration (m/s^2)

The recommended values of hydrodynamic coefficients for the on-bottom stability design as a function of the embedment of the pipeline are listed in Table 6-1.

Coefficient	Pipe embedment			Riser
	0%	**10%**	**20%**	
Drag	0.70	0.63	0.53	1.0
Lift	0.90	0.90	0.81	-
Inertia	3.29	2.80	2.30	2.0

Table 6-1 Overview hydrodynamic coefficients

The wave induced water particle velocities and accelerations will be determined using the appropriate wave theory for the design wave height, period and water depth. Phase shifts between horizontal and vertical water particle velocities will be considered.

6.2.3. Stability check

The stability of the pipelines is checked using the following relationship:

$$W_s > f_s \cdot \left(\frac{F_D + F_I}{f_w} + F_L \right) - \frac{F_P}{f_w}$$

Where:

- W_s = pipeline submerged weight (N/m)
- f_s = safety factor (-) => 1.1
- F_D = drag force (N/m)
- F_L = lift force (N/m)
- f_w = friction factor (-)
- F_I = inertia force (N/m)
- F_P = passive soil resistance (N/m)

A safety factor (f_s) of 1.1 will be implemented. The above equation assumes absolute stability criteria. Note that the actual F_p is limited to the maximum of the combined drag and inertia forces.

The passive soil resistance is derived from:

$$F_p = 0.5 \cdot \rho_{soil} \cdot \varepsilon^2 \cdot K_p$$

Where:

- ρ_{soil} = submerged soil density (kg/m^3)
- ε = embedment of pipeline (m)
- K_P = coefficient of passive soil resistance (-)

and K_P is calculated from :

$$K_P = \frac{1 + \sin(\phi)}{1 - \sin(\phi)} = \tan^2 \cdot \left(45 + \frac{\phi}{2} \right)$$

Where:

- ϕ = angle of internal friction (°)

6.3. Implosion

6.3.1. External overpressure

The collapse pressure p_c causing implosion (radial instability) can be determined using:

$$(P_c - P_e) \cdot (P_c{}^2 - P_p{}^2) = P_c \cdot P_e \cdot P_p \cdot 2 \cdot \delta_0 \cdot \frac{D_g}{t}$$

Where:

D_g	=	nominal diameter of pipe (mm)
P_c	=	critical external pressure for collapse (N/mm2)
P_e	=	critical external pressure for elastic deformation (N/mm^2)
P_p	=	critical external pressure for plastic deformation (N/mm^2)
P_L	=	allowable external pressure (N/mm^2)
δ_0	=	initial deformation (mm)
t	=	nominal wall thickness (mm)

$$D_g = \frac{1}{2} \cdot \{OD_{nom} - (OD_{nom} - 2 \cdot t_{min})\}$$

The critical external pressure for plastic deformation is calculated from:

$$P_p = \frac{2 \cdot R_e \cdot t}{D_{nom}}$$

The critical external pressure for elastic deformation is calculated from:

$$P_e = \frac{2 \cdot E}{1 - \nu^2} \cdot \left(\frac{t}{D_{nom}}\right)^3$$

Where:

ν	=	Poisson's ratio for elastic deformation (-) => 0.3

As a part of this the initial deformation is derived from:

$$\delta_0 = \frac{D_{\max} - D_{\min}}{D_{\max} + D_{\min}}$$

Where:

D_{max}	=	largest diameter of the ovalized pipe cross section
D_{min}	=	smallest diameter of the ovalized pipe cross section

The maximum allowable external pressure is defined as:

$$\gamma_{g,p} \cdot P_L \leq \frac{\gamma_M \cdot P_c}{\gamma_{m,p}}$$

Where:

$\gamma_{g,p}$	=	load factor (-) => 1.05
γ_M	=	model factor (-) => 0.93
$\gamma_{m,p}$	=	material factor (-) => 1.45

6.3.2. Bending moment

In case of a bending moment on the pipe, the moment which will cause buckling is calculated from the plastic moment of the pipe section.

$$M_c = D_{nom}{}^2 \cdot t \cdot R_e$$

The maximum allowable bending moment is defined as:

$$\gamma_{g,M} \cdot M_L \leq \frac{\gamma_M \cdot M_c}{\gamma_{m,M}}$$

Where:

$\gamma_{g,M}$	=	load factor (-) => 1.1
γ_M	=	model factor (-) => 1.0
$\gamma_{m,M}$	=	material factor (-) => 1.3
M_L	=	allowable bending moment for buckling (Nm)
M_c	=	critical bending moment for buckling (Nm)

6.3.3. Combined external pressure and bending moment

When external pressure exists in combination with a bending moment besides the checks above the condition for combined stresses as shown below shall be fulfilled.

$$\frac{\gamma_{g,p} \cdot P_L}{P_c / \gamma_{m,p}} + \left(\frac{\gamma_{g,m} \cdot M_L}{M_c / \gamma_{m,M}} \right)^n \leq \gamma_M$$

Where:

$$n = 1 + 300 \cdot \frac{t}{D_{nom}}$$

Where:

$\gamma_{g,p}$	=	load factor for pressure (-) => 1.05
$\gamma_{g,m}$	=	load factor for bending (-) => 1.55
γ_M	=	model factor (-) => 0.93
$\gamma_{m,p}$	=	material factor for pressure (-) => 1.25
$\gamma_{m,M}$	=	material factor for bending (-) =>1.15
M_L	=	allowable bending moment for buckling (Nm)
M_c	=	critical bending moment for buckling (Nm)

6.4. Progressive plastic collapse

Progressive plastic deformation load cycle will lead to extreme deformation, collapse and cracks initiation through the wall.

The condition for avoiding buckle propagation is:

$$\varepsilon_{\max} = \alpha \cdot \Delta T \leq \left[\frac{R_{ev}}{E} \cdot \sqrt{1 - \frac{3}{4} \left(\frac{\sigma_h}{R_{ev}} \right)^2} + \frac{R_e}{E} \sqrt{0.9 - \frac{3}{4} \left(\frac{\sigma_h}{R_e} \right)^2} \right]$$

Where:

α	=	coefficient of linear thermal expansion (m/ m/ ° C)
ΔT	=	temperature differential [° C] (design – installation)

Parameters have to be factored as defined in section 6.

6.5. Local buckling

In accordance with NEN 3656, if OD / t < 55, an assessment on local buckling can generally be omitted.

For this project it would mean that a local buckling check is required for a wall thickness of maximum 5.0 mm, which will be much smaller than the anticipated wall thickness based on internal pressure and on-bottom stability. This will be checked during detailed design.

6.6. Bar buckling

In a free span the pipeline will be susceptible to bar buckling. Bar buckling may occur due to an effective axial compressive force (N) in the pipeline. The compressive force in an axially restrained pipeline is based on the longitudinal stress:

$$N = A \cdot (\nu \cdot S_h - \gamma_t \cdot E \cdot \alpha \cdot \Delta T)$$

Where:

A	=	cross sectional area of steel (mm^2)
ν	=	Poisson's ratio for elastic deformation (-) => 0.3
S_h	=	factored hoop stress (N/mm^2)
γ_t	=	load factor as given in Table 5-3 (-)
α	=	coefficient of thermal expansion (m/m/°C)
ΔT	=	pipeline temperature differential (° C) (design – installation)

The factored hoop stress (S_h) is calculated from:

$$S_h = \gamma_P \cdot \sigma_h$$

and

$$\sigma_h = \frac{P_d \cdot (OD - t_{\min})}{2 \cdot t_{\min}}$$

Where:

P_d	=	design pressure (N/mm^2)
t_{min}	=	minimum pipe wall thickness (mm)
OD	=	outside diameter of steel pipe (mm)
γ_P	=	load factor as given in Table 5-3 (-)

The buckling length is based on the Euler buckling load definition, defined in Ref. [3]. Bar buckling is avoided if the span length fulfils:

$$L \leq \sqrt{4 \cdot \pi^2 \frac{E \cdot I}{|N|}}$$

Where:

L	=	allowable span length (mm)
I	=	moment of inertia (mm^4)

7. Free Span analysis

Spanning of a pipeline on the seabed causes forces and stresses in the pipe. The criterion for accepting a pipeline configuration is that the pipe should not be subjected to over-stressing, nor to excessive dynamic loading because of resonant oscillations of the pipe caused by the vortex shedding phenomenon during installation, testing and throughout its operating life.

The pipeline span assessment includes the following items:

- Static span analysis
- Dynamic span analysis.

The static analysis concerns the determination of the pipe stresses under functional- and static environmental loads for a given span length.

The dynamic span analysis is based on criteria for prevention of vortex induced vibrations (VIV) as outlined in NEN 3656 considering both current- and wave induced velocities.

In addition, operational limits of the trenching equipment, limits the span gap (distance between the pipe and the seabed).

Although the pipeline will be buried below the seabed prior to its operation, the pipeline must be checked for spanning for the period between installation and burial.

In the analysis, along with the seabed topography, both functional and environmental loads are taken into consideration to check pipeline structural integrity under the considered load cases.

7.1. Static span

Combining hoop, longitudinal and bending stresses in the pipeline, which shall satisfy criteria for equivalent stresses, gives the maximum allowable static span lengths. Checks are to be made for the installation, hydro test and operational load case.

The maximum bending moment is calculated from the (vector) combination of the pipelines' own weight and hydrodynamic forces for the maximum wave condition:

$$q = \sqrt{{\gamma_W}^2 \cdot {W_S}^2 + {\gamma_H}^2 \cdot (F_D + F_I)^2}$$

Where:

γ_W = load factor as per Table 5-3 (-)

γ_H = load factor as per Table 5-3 (-)

End fixity of an actual span is commonly assumed between fixed - fixed and fixed – pinned and the bending moment (M) calculated from:

$$M = \frac{q \cdot L^2}{10}$$

Where:

L = Maximum allowable span length [m]

The maximum allowable bending moment (M_{all}) is given by:

$$M_{all} = \frac{2 \cdot I \cdot \sigma_b}{OD}$$

Where:

I = moment of inertia (m^4)

OD = pipeline outside diameter (m)

s_b = maximum allowable bending stress

The maximum allowable static span can then be determined by:

$$L\max = \sqrt{\frac{20 \cdot \sigma_b \cdot I}{OD \cdot q}}$$

The maximum allowable span length follows from the condition that the equivalent stress (S_e) from the load combination satisfies the following conditions:

For the operational and hydrotest cases: $S_e \leq 0.85 \times (R_e + R_{ev}) / \gamma_m$

For the installation case: $S_e \leq R_e / \gamma_m$

Where:

R_e = minimum yield stress at 20 °C (N/mm^2)

R_{ev} = minimum yield stress at design temperature (N/mm^2)

γ_m = material factor (-) => 1.1

7.1.1. Load cases

The maximum static span will be determined for the load cases, and considering the environmental load return periods, as detailed in Table 7-1:

Condition	Wave Height Return Period	Current velocity Return Period
Installation	$H_{max,1yr}$	1 yr
Hydrotest	$H_{max,1yr}$	1 yr
Operational,1	$H_{max,100yr}$	10 yr
Operational,2	$H_{max,10yr}$	100 yr

Table 7-1 Load Cases for Span Assessment

7.2. Dynamic span

Flow of water particles induced by currents and waves perpendicular to a spanning pipeline or riser span can lead to vortices being shed. This will disrupt the flow around the pipe and thereby potentially cause periodic loads on the pipeline or riser, also known as Vortex Induced Vibration (VIV).

The natural frequency of a span being close to the vortex shedding frequency can result in a resonant oscillation, possibly resulting in fatigue failure of the pipeline or riser.

The oscillations of the span may occur in two directions:

- in line with the flow (parallel to the flow direction of the water particles)
- in cross flow direction (perpendicular to the flow direction of the water particles)

When assessing VIV, the span should be confirmed to be within acceptable limits set by either avoidance of VIV or an acceptable fatigue life for both the installation and operational condition.

Relevant dimensionless parameters governing the VIV phenomenon are the reduced velocity (V_r) and stability parameter (K_s).

The reduced velocity (V_r) parameter is defined by:

$$V_r = \frac{V_s}{f_{n \cdot OD_{tot}}}$$

Where,

V_s	=	water particle velocity due to current and significant wave (m/s)
f_n	=	1^{st} natural frequency of the pipe span (1/s)
OD_{tot}		total outside diameter of the pipe (m)

The 1st natural frequency can be calculated from:

$$f_n = \frac{a}{2\pi} \cdot \sqrt{\frac{E \cdot I}{m_e \cdot L^4}}$$

Where,

a	=	frequency factor (-) => 15.4 for a fixed-pinned beam, which is used for the pipe
E	=	Young's modulus (N/m^2)
I	=	moment of inertia (m^4)
L	=	length of span in pipeline / riser (m)

The effect of the CWC on the moment of inertia and the Young's modulus is not taken into account; this is a conservative approximation. The outer diameter is including the CWC.

The stability parameter (K_s) is defined by:

$$K_s = \frac{2 \cdot m_e \cdot \delta}{\rho_{sw} \cdot OD_{tot}^2}$$

Where,

m_e	=	effective mass of pipe (kg/m)
ρ_{sw}	=	density seawater (kg/m^3)
δ	=	logarithmic decrement of damping (-) => δ = 0.126 for steel

The effective mass of the pipe can be calculated as:

$$m_e = m + \pi/4 \cdot C_M \cdot \rho_{sw} \cdot OD_{tot}{}^2$$

Where,

m	=	Pipeline / riser mass (kg/m)
Cm	=	added mass coefficient (-)

NEN 3656 states that In-line oscillations will occur if $K_s \leq 1.8$ and cross flow oscillations will occur if $K_s \leq 16$.

7.2.1. In-line VIV

NEN 3656 furthermore states that in-line oscillations of the span occur if the reduced velocity is within the range of: $1.0 \leq Vr \leq 3.5$

Vortices around a spanning pipe occur in a relatively steady state environment. The wave induced velocity varies from a maximum at t=0, to zero at t=1/4*Twave. Furthermore, the system does not respond instantaneously to the applied forcing. To ignore the wave induced velocity in assessing the allowable dynamic span length would be too optimistic, to account for the maximum induced value would be too conservative, therefore reference is made to DNV-RP-F105. “Free Spanning Pipelines.” (ref. [3]).

According to Ref. [3], fatigue damage due to in-line VIV can be neglected if the current flow velocity ratio α, as defined by the equation below is smaller than 0.8.

$$\alpha = \frac{v_{cur}}{v_{cur} + v_{wave}}$$

Where,

v_{cur}	=	Particle velocity due to current [m/s]
v_{wave}	=	Particle velocity due to waves [m/s]

7.2.2. Cross-flow VIV

The occurrence of cross flow oscillations depends on the magnitude of the Reynolds number, Re, and the reduced velocity as given in Figure 7-1.

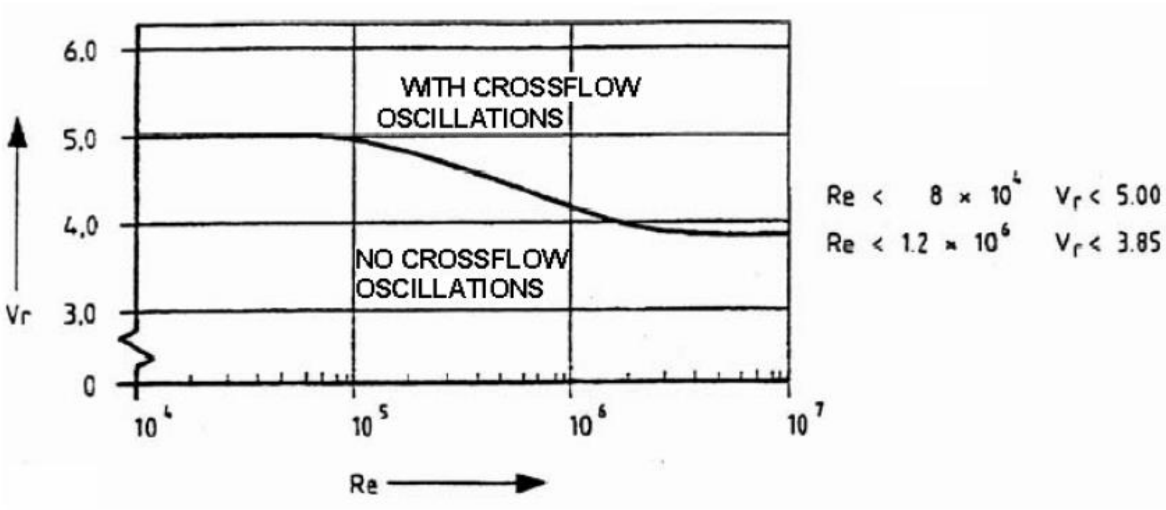


Figure 7-1 Reduced velocity for cross flow oscillations

$$\mathrm{Re} = \frac{\mathrm{v} \cdot OD_{tot}}{\nu}$$

Where,

v	=	particle velocity (m/s)
OD_{tot}	=	pipeline outside diameter (m)
n	=	Kinematic viscosity water (m^2/s) => 1,307 x 10^{-6} (at 10 °C)

8. Bottom roughness

8.1. General

To ensure the structural integrity of the pipeline over its entire design life finite element analyses will be carried out using industry proven software like Ansys or RFEM.

The analysis will assess the interaction between the pipeline and the supporting soil along the entire pipeline route and will be carried out in accordance with the requirements of NEN 3656 (Ref. [1]). The analysis will determine the number of spans exceeding the allowable span length and the subsequent pre-sweeping requirements. The design loads at the tie-in locations will be determined and in addition the analysis will assess the upheaval buckling response of the pipeline system under operating conditions.

The analysis will account for the load history of the pipelines over the design life by considering the following load cases:

- Installation (empty);
- Installation (flooded);
- Pipeline operation - nominal (nominal wall thickness content filling maximum operating pressure and temperature);
- Pipeline operation - corroded (corroded wall thickness content filling maximum operating pressure and temperature).

The pipeline will be modelled by uniaxial elements with tension-compression torsion and bending capabilities and can account for internal pressure effects. The element is a 3D element with six degrees of freedom translations in the x y and z directions and rotations about the x y and z axes. In addition, the element needs to account for buoyancy wave and current loads and to be capable of large deflections and rotations.

The pipeline is to be modelled with a maximum element length of 0.5 – 1.0 m and accounts for all curvatures in the horizontal plane and undulations in the vertical plane. Pipe-soil interaction is simulated using three independent non-linear spring elements attached to each pipe element. The springs represent the soil frictional resistance in the axial and lateral directions and the soils bearing capacity in the vertical direction.

For sections of the pipeline which are buried additional vertical non-linear springs representing the uplift resistance of the trench backfill material will be attached to the pipe elements.

Seabed roughness will be simulated by displacing the vertical springs representing the soil bearing capacity to the correct depth based on the bathymetric data and allowing the pipe to move and rest on the vertical springs.

When the depth of the pipeline at a certain point is less than the depth of the seabed a "free span" is identified. Similar succeeding joints indicate a larger span. The length of the free span is determined by subtracting the coordinates of the beginning of the span from the coordinates of the span end.

At pipeline termination points an additional axial spring will be attached to the pipeline ends to incorporate the structural response of the subsea tie-in spool/riser and supporting piping.

8.2. Pipe-soil interaction

The characteristics of the springs which simulate the pipe-soil interaction are defined through non-linear force deflection curves. These force-deflection curves describe the frictional restraint provided by the soil to the pipeline in the axial lateral direction and the soils bearing capacity /upwards resistance in the vertical direction.

2 situations can be distinguished:

- exposed pipeline
  - axial soil resistance;
  - lateral soil resistance;
  - vertical bearing capacity (downward resistance);

- buried pipeline
  - axial soil resistance;
  - lateral soil resistance;
  - vertical bearing capacity (downward resistance);
  - vertical upward soil resistance;

Table 8-1 gives an overview of the calculation basis of the mentioned soil resistances/capacities.

Direction	Exposed pipeline	Buried pipeline
Axial	Function of pipe submerged weight and axial Coulomb friction coefficient	Function of pipe diameter, burial depth and effective unit soil weight.
Lateral	Combination of Coulomb friction part and passive soil resistance due to build-up of soil penetration (ref. [5])	Based on horizontal bearing capacity factor (ref. [9])
Vertical bearing	Based on bearing capacity formulas for ideal 2-D strip foundations ref. [3]	Based on bearing capacity formulas for ideal 2-D strip foundations ref. [3]
Vertical upward	N/A	As per ref. [6] based on burial depth pipe diameter and submerged soil weight

Table 8-1 Overview soil resistance/capacity calculation basis

9. Upheaval Buckling

Buried pipelines exposed to compressive effective axial forces may get unstable beyond its anchor point and move vertically out of the seabed if the cover has insufficient resistance. An out-of-straightness configuration will result in forces acting on the cover perpendicular to the pipeline. In case these vertical forces exceed the cover resistance the pipeline will buckle upwards.

The relation between minimum required cover height and the imperfection height (out-of-straightness) will be established in accordance with ref. [11].

Parameters used in the assessment of upheaval buckling are the dimensionless imperfection length parameter (Φ_L):

$$\Phi_L = L \cdot \sqrt{\frac{N_e}{EI}}$$

Where:

L	=	exposure length (m)
N_e	=	effective axial compressive force (N)
EI	=	bending stiffness (N m^2)

And the dimensionless maximum download parameter (Φ_w):

$$\Phi_w = \frac{w \cdot E \cdot I}{\Delta_{calc} \cdot N_e^2}$$

Where:

w	=	required download [N/m]
Δ_{calc}	=	imperfection height [m]

Depending on the Φ_L value the required download is derived from Φ_w in accordance with:

$$\Phi_w = 0.0646 \text{ for } \Phi_L < 4.49$$

$$\Phi_w = \frac{5.68}{\phi_L^2} - \frac{88.35}{\phi_L^4} \text{ for } 4.49 < \Phi_L < 8.06$$

$$\Phi_w = \frac{9.6}{\phi_L^2} - \frac{343}{\phi_L^4} \text{ for } \Phi_L > 8.06$$

In cohesionless soils the uplift resistance (q) due to the cover of the pipe can be calculated from:

$$q = \gamma \cdot H \cdot OD \cdot \left(1 + f \cdot \frac{H}{OD}\right)$$

Where:

γ	=	effective under water weight of soil (N/m^3)
H	=	depth of cover (m)
OD	=	outside diameter of pipe (m)
f	=	uplift coefficient 0.5 for dense material 0.1 for loose material

The calculated required download (w) shall be smaller than the actual combination of the submerged weight and uplift resistance of the pipeline.

The simplified method from Reference [11] is conservative in that it does not model a number of mitigating factors such as:

- The finite axial stiffness of the pipeline which determines how rapidly the axial force diminishes as the pipeline moves upwards
- The pipeline resistance to axial movement through the soil determines how far the pipeline can slide towards a developing buckle.

Both the above factors may cause progressive upheaval buckling predicted by the analysis method in Reference [11] not to occur.

Further the sinusoidal imperfection profile assumed in the model is envisaged to yield conservative download requirements.

The results will be presented as a maximum imperfection length with respect to the cover depth and the imperfection height.

10. Cathodic Protection

As per NEN 3656 the cathodic protection system of the pipeline bundle will be designed as per ref. [12]. The characteristics of a typical anode element are given in Table 10-1.

Item	Value
Type	Half Shell Bracelet
Material	Aluminium
Cable connections	2 x @ 20" pipeline

Table 10-1 Typical anode characteristics

The cathodic protection will be designed to prevent external corrosion of the pipeline. The mass and spacing of the anodes will be such that the following criteria are met:

- Total anode mass to meet the mean and final current demand over the design life of the pipeline.
- Anode current output to meet the required current output at the end of the design life.
- Anode separation not to exceed a value of 300 m.

The pipeline will be divided in to sections where changes in conditions, such as water depth, operating temperature or burial, can give rise to variations in design current density.

From the pipeline dimensions and the coating selected, the mean current demand, I_{cm}, and the final demand, I_{cf}, shall be calculated separately as per the following:

$$I_c = A_c \cdot f_c \cdot i_c$$

Where:

I_c = the current demand for a specific pipeline section calculated for mean and final conditions (A)
A_c = the total surface area for a specific pipeline section (m^2)
f_c = the coating breakdown factor determined for mean and final conditions (-)
i_c = the current density selected for mean and final conditions (A/m^2)

For pipelines fully buried, a design current density (mean and final) of 20 mA/m^2 should be used irrespective of seawater temperature, oxygen content or depth as per Section 7.4.3 of Ref. [12].

The coating breakdown factors for mean and final conditions, f_c, taking into consideration the deign life of the pipeline, are calculated as follows.

The mean coating breakdown factor, $\overline{f_c}$, is determined by:

$$\overline{f_c} = f_i + (0.5\Delta f \cdot t_{dl})$$

And the mean coating breakdown factor, f_f , is determined by

$$f_f = f_i + (\Delta f \cdot t_{dl})$$

Where:

f_i = the initial coating breakdown factor at the start of pipeline operation (-)
Δf = the average yearly increase in the coating breakdown factor (-)
t_{dl} = the design life (yrs)

The initial coating breakdown factor and average yearly increase in breakdown factor are dependent on the anti-corrosion coating and field joint coating material. Values for various coating are taken from [12] and reported in Table 9-2.

Factory-applied coating type	Field joint coating type	f_i	Δf
Fusion-bonded epoxy (FBE)	Heat-shrinkable sleeves (HSS[a])	0,080	0,003 5
	FBE	0,060	0,003 0
Three-layer coating systems including epoxy, adhesive and polyethylene (3LPE)	HSS[a]	0,009	0,000 6
	FBE	0,008	0,005
	Multilayer coating including epoxy and PE (e.g. moulded, HSS[a] or flame spray)	0,007	0,000 5
Three-layer coating systems including epoxy, adhesive and polypropylene (3LPP)	HSS[a]	0,007	0,000 3
	FBE	0,006	0,000 2
	Multilayer coating including epoxy and PP (e.g. HSS[a], hot tapes, moulding or flame spray)	0,005	0,000 2
Heat insulation multilayer coating systems including epoxy, adhesive and/or PE, PP or PU	Thick multilayer coating systems including epoxy, adhesive and/or PE, PP, PU, HSS[a] or a combination of these products.	0,002	0,000 1
Thick coatings: elastomeric materials (e.g. polychloroprene or EPDM) or glassfibre-reinforced resins	Thick elastomeric materials or glassfibre-reinforced resins	0,002	0,000 1
Flexible pipelines	Not applicable (mechanical couplings)	0,002	0,000 1

[a] HSS can be used with or without primer.

Table 10-2 Coating breakdown factors [12]

Having established the mean current demand, the total required mass of anode material for a specific pipeline section is determined as follows:

$$m = I_{cm} \cdot t_{dl} \cdot \frac{8760}{\mu \cdot \varepsilon}$$

Where:

m = the total net anode mass, for the specific pipeline section (kg)

I_{cm} = the mean current demand for the specific pipeline section (A)

μ = is the utilization factor (-) = 0.8 for bracelet anodes as per Section 8.4 of Ref. [12].

ε = the electrochemical capacity of the anode material per kilogram (A/h)

The electrochemical capacity of the anode material is dependent on the surface temperature of the anode and its burial status. The applicable values are taken from Section 8.3 of Ref. [12] and reported in Table 9-3.

Having determined the total net anode mass required to meet the current demand, the minimum number of anodes required in a specific pipeline section, will be determined as follows:

$$n = \frac{m}{m_a}$$

Where:

n = the number of anodes to be installed on the specific pipeline section (-)

m_a = the individual net anode mass (kg)

The minimum number of anodes, n, shall be determined considering the maximum allowable anode spacing of 300m as reported in Section 8.1 of Ref. [12].

Anode type	Anode surface temperature[a]	Immersed in seawater		Buried in seawater sediments[d]	
		Potential	Electrochemical capacity	Potential	Electrochemical capacity
		Ag/AgCl/ seawater	ε	Ag/AgCl/ seawater	ε
	°C	mV	A·h/kg	mV	A·h/kg
Aluminium	< 30	– 1 050	2 000	– 1 000	1 500
	60	– 1 050	1 500	– 1 000	800
	80[b]	– 1 000	900	– 1 000	400
Zinc	< 30	– 1 030	780	– 980	750
	> 30 to 50[c]			– 980	580

Electrochemical capacity for a given alloy is a function of temperature and anode current density. Reference is made to Annex A for guidance on CP design for variations in anode current densities.

For non-buried pipelines, the anode surface temperature should be taken as the external pipeline temperature and not the internal fluid temperature. For buried pipelines, the anode surface temperature shall be taken as the internal fluid temperature.

[a] For anode surface temperatures between the limits stated, the electrochemical capacity shall be interpolated.

[b] For aluminium anodes, the anode surface temperature shall not exceed 80 °C unless the performance has been demonstrated in tests and has been documented.

[c] For zinc anodes, the anode surface temperature shall not exceed 50 °C unless satisfactory performance has been demonstrated in tests and has been documented.

[d] Pipelines which are rock-dumped shall be considered as buried in seawater sediments.

Table 10-3 Design values for galvanic anodes [12]

To provide the required current, the actual anode current output shall be greater than or equal to the required current output:

$$I_{af} \geq I_f$$

Where:

I_{af} = the actual end-of-life individual current output (A)

I_f = the required end-of-life individual anode current output (A)

The required end-of-life individual anode current output, I_f, shall be calculated from the following:

$$I_f = \frac{I_{cf}}{n}$$

Where:

I_{cf} = the total current demand for the protection of the specific pipeline section at the end of life (A)

For a given anode size and mass, the actual individual anode current output at the end of life, I_{af}, is calculated from the below equation:

$$I_{af} = \frac{E_c - E_a}{R_a}$$

Where:

E_c = the design protection potential (V)

E_a = the design closed-circuit potential of the anode (V)

R_a = the total circuit resistance, which is assumed to be equivalent to the anode resistance (ohms)

The anode resistance, R_a, shall be calculated as follows:

$$R_a = 0.315 \frac{\rho}{\sqrt{A}}$$

Where:

ρ = the environmental resistivity (ohm.m)

A = the exposed surface area of the anode (m^2)

For determining the end-of-design-life anode-to-seawater resistance, the anodes shall be assumed to be consumed to an extent given by their utilization factor. The approximate anode dimensions (exposed surface area) corresponding to this degree of wastage shall be used in the anode resistance formula for R_a.

A. Environmental Data GEOxyz

Magnetic Contacts

MAG ID	Easting	Northing	Size nT
MAG_001	717953,7	5940271,5	1846
MAG_002	717991,0	5940276,5	2449
MAG_003	718039,9	5940290,0	1412
MAG_004	718041,2	5940299,0	88
MAG_005	718096,4	5940310,5	5750
MAG_006	718148,3	5942788,5	35
MAG_007	718149,5	5940331,0	2207
MAG_008	718198,9	5940350,5	4606
MAG_009	718247,8	5940365,0	878
MAG_010	718312,4	5940395,0	4218
MAG_011	718346,7	5940412,0	1847
MAG_012	718409,7	5940429,5	1254
MAG_013	718424,0	5944905,0	44
MAG_014	718444,3	5942692,5	828
MAG_015	718462,9	5941110,5	163
MAG_016	718472,4	5940453,5	1966
MAG_017	718484,8	5942724,5	4590
MAG_018	718491,8	5940449,0	962
MAG_019	718506,9	5942723,0	1900
MAG_020	718508,2	5942754,0	9330
MAG_021	718509,3	5940455,5	558
MAG_022	718516,3	5942748,5	5361
MAG_023	718534,0	5942694,0	1157
MAG_024	718548,1	5945123,5	32

MAG_025	718565,1	5940481,0	3279
MAG_026	718595,9	5942616,0	52
MAG_027	718617,5	5940493,0	5243
MAG_028	718662,3	5940506,0	613
MAG_029	718720,1	5940516,0	2386
MAG_030	718766,9	5940523,0	2963
MAG_031	718829,4	5940541,0	706
MAG_032	718856,6	5940558,0	9291
MAG_033	718875,8	5944329,5	23
MAG_034	718975,9	5941798,0	86
MAG_035	718995,8	5942736,5	67
MAG_036	719033,8	5946829,5	22
MAG_037	719274,9	5946749,5	136
MAG_038	719349,1	5948063,0	51
MAG_039	719395,2	5946438,0	14
MAG_040	719449,5	5948089,0	11
MAG_041	719489,0	5947981,0	40
MAG_042	719645,7	5947744,5	73
MAG_043	720080,7	5949053,0	11
MAG_044	720398,8	5952407,0	22
MAG_045	720432,3	5952500,5	428
MAG_046	720451,3	5952357,0	15
MAG_047	720452,1	5952553,0	197
MAG_048	720492,5	5952478,5	6757
MAG_049	720507,6	5952530,5	846
MAG_050	720589,2	5952492,5	539
MAG_051	720687,5	5951846,0	11
MAG_052	720733,6	5952469,5	17

MAG_053	720796,44	5954306,50	11
MAG_054	720823,9	5952486,5	38
MAG_055	720895,0	5952512,5	195
MAG_056	720896,6	5952528,5	258
MAG_057	720966,9	5952512,5	155
MAG_058	720972,6	5952521,0	30
MAG_059	720981,25	5955029,50	15
MAG_060	721006,69	5954892,50	18
MAG_061	721006,69	5954892,5	18
MAG_062	721043,6	5954396,5	50
MAG_063	721043,63	5954396,50	50
MAG_064	721043,6	5954396,5	50
MAG_065	721050,88	5954393,50	66
MAG_066	721050,9	5954393,5	66
MAG_067	721050,9	5954393,5	66
MAG_068	721097,9	5953584,0	8
MAG_069	721144,6	5952537,5	59
MAG_070	721224,2	5952542,0	88
MAG_071	721272	5954784,5	23
MAG_072	721272,00	5954784,50	23
MAG_073	721272,0	5954784,5	23
MAG_074	721395,3	5952547,0	97
MAG_075	721424,3	5952569,5	110
MAG_076	721424,88	5954616,50	285
MAG_077	721424,9	5954616,5	285
MAG_078	721424,88	5954616,5	285
MAG_079	721424,9	5954616,5	285
MAG_080	721430,5	5952680,5	22

MAG_081	721567,25	5954416,50	12
MAG_082	721567,3	5954416,5	12
MAG_083	721567,25	5954416,5	12
MAG_084	721567,3	5954416,5	12
MAG_085	721568,5	5954404,5	22
MAG_086	721568,50	5954404,50	22
MAG_087	721571,7	5954762,5	18
MAG_088	721571,69	5954762,50	18
MAG_089	721571,69	5954762,5	18
MAG_090	721571,7	5954762,5	18
MAG_091	721615,3	5954915,0	27
MAG_092	721615,25	5954915,00	27
MAG_093	721615,25	5954915	27
MAG_094	721615,3	5954915	27
MAG_095	721625,25	5954596,50	53
MAG_096	721625,3	5954596,5	53
MAG_097	721625,25	5954596,5	53
MAG_098	721625,3	5954596,5	53
MAG_099	721625,4	5954919,0	28
MAG_100	721625,38	5954919,00	28
MAG_101	721625,38	5954919	28
MAG_102	721625,4	5954919	28
MAG_103	721645,7	5954971,5	66
MAG_104	721645,69	5954971,50	66
MAG_105	721645,69	5954971,5	66
MAG_106	721645,7	5954971,5	66
MAG_107	721650,5	5954550	376
MAG_108	721650,50	5954550,00	376

MAG_109	721650,5	5954550,0	376
MAG_110	721657,8	5954589	358
MAG_111	721657,8	5954589,0	358
MAG_112	721657,81	5954589,00	358
MAG_113	721657,81	5954589	358
MAG_114	721658,0	5954624,0	45
MAG_115	721658,00	5954624,00	45
MAG_116	721658	5954624	45
MAG_117	721666,7	5954576,0	1100
MAG_118	721666,69	5954576,00	1100
MAG_119	721666,69	5954576	1100
MAG_120	721666,7	5954576	1100
MAG_121	721670,5	5954647,5	27
MAG_122	721670,50	5954647,50	27
MAG_123	721672,2	5954562,0	2733
MAG_124	721672,19	5954562,00	2733
MAG_125	721672,19	5954562	2733
MAG_126	721672,2	5954562	2733
MAG_127	721683,56	5954529,00	252
MAG_128	721683,6	5954529,0	252
MAG_129	721683,56	5954529	252
MAG_130	721683,6	5954529	252
MAG_131	721685,69	5954453,00	110
MAG_132	721685,7	5954453,0	110
MAG_133	721685,69	5954453	110
MAG_134	721685,7	5954453	110
MAG_135	721691,2	5954590,0	360
MAG_136	721691,19	5954590,00	360

MAG_137	721691,19	5954590	360
MAG_138	721691,2	5954590	360
MAG_139	721695,69	5954426,00	35
MAG_140	721695,7	5954426,0	35
MAG_141	721695,69	5954426	35
MAG_142	721695,7	5954426	35
MAG_143	721702,2	5954504,0	58
MAG_144	721702,19	5954504,00	58
MAG_145	721702,19	5954504	58
MAG_146	721702,2	5954504	58
MAG_147	721708,19	5954468,00	119
MAG_148	721708,2	5954468,0	119
MAG_149	721708,19	5954468	119
MAG_150	721708,2	5954468	119
MAG_151	721709,3	5954964,0	21
MAG_152	721709,25	5954964,00	21
MAG_153	721709,25	5954964	21
MAG_154	721709,3	5954964	21
MAG_155	721806,3	5954401,5	10
MAG_156	721806,3	5954401,5	10
MAG_157	721806,31	5954401,50	10
MAG_158	721806,31	5954401,5	10
MAG_159	722858,06	5954425,00	43
MAG_160	722858,1	5954425,0	43
MAG_161	722858,1	5954425	43
MAG_162	723840,1	5954855,5	31
MAG_163	723840,13	5954855,50	31
MAG_164	723843,06	5954772,50	17

MAG_165	723843,1	5954772,5	17
MAG_166	723868,19	5954698,50	23
MAG_167	723868,2	5954698,5	23
MAG_168	723879,8	5954617	25
MAG_169	723879,81	5954617,00	25
MAG_170	723905,06	5954389,00	15
MAG_171	723905,1	5954389,0	15
MAG_172	723905,1	5954389	15
MAG_173	723911,8	5954159	16
MAG_174	723911,81	5954159,00	16
MAG_175	723927,25	5954010,00	14
MAG_176	723927,3	5954010	14
MAG_177	723945,06	5953933,50	16
MAG_178	723945,1	5953933,5	16
MAG_179	724080,88	5954522,00	40
MAG_180	724080,9	5954522,0	40
MAG_181	724080,9	5954522	40
MAG_182	724147,19	5954742,00	61
MAG_183	724147,2	5954742	61
MAG_184	724181,8	5954587,5	57
MAG_185	724181,81	5954587,50	57
MAG_186	724182,56	5954368,00	43
MAG_187	724182,6	5954368,0	43
MAG_188	724182,6	5954368	43
MAG_189	724191,56	5954659,00	54
MAG_190	724191,6	5954659	54
MAG_191	724205	5954508,5	31
MAG_192	724205,00	5954508,50	31

MAG_193	724205,0	5954508,5	31
MAG_194	724223,6	5954348,5	27
MAG_195	724223,63	5954348,50	27
MAG_196	724223,6	5954348,5	27
MAG_197	724298,25	5954723,50	41
MAG_198	724298,3	5954723,5	41
MAG_199	724410,1	5954332	36
MAG_200	724410,13	5954332,00	36
MAG_201	724410,1	5954332,0	36
MAG_202	724420,9	5954339	38
MAG_203	724420,94	5954339,00	38
MAG_204	724420,9	5954339,0	38
MAG_205	724426,56	5954103,00	27
MAG_206	724426,6	5954103	27
MAG_207	724436,6	5954034	31
MAG_208	724436,63	5954034,00	31
MAG_209	724442,19	5954251,00	18
MAG_210	724442,2	5954251,0	18
MAG_211	724442,2	5954251	18
MAG_212	724449,06	5954180,50	16
MAG_213	724449,1	5954180,5	16
MAG_214	724449,1	5954180,5	16
MAG_215	724509,3	5953941,5	48
MAG_216	724509,31	5953941,50	48
MAG_217	724512,88	5954320,50	12
MAG_218	724512,9	5954320,5	12
MAG_219	724512,9	5954320,5	12
MAG_220	724611,8	5953854,5	26

MAG_221	724611,81	5953854,50	26
MAG_222	724706,25	5953751,50	26
MAG_223	724747,06	5953610,50	37
MAG_224	724772,75	5953676,00	29
MAG_225	725618,75	5953886,50	38
MAG_226	725618,8	5953886,5	38
MAG_227	726342,9	5953654	25
MAG_228	726342,94	5953654,00	25
MAG_229	727182,38	5954201,00	25
MAG_230	727182,4	5954201,0	25
MAG_231	727182,4	5954201	25
MAG_232	727518,9	5953952	5
MAG_233	727518,94	5953952,00	5
MAG_234	728994,88	5954791,50	14
MAG_235	728994,9	5954791,5	14
MAG_236	728994,9	5954791,5	14
MAG_237	729047,19	5955011,50	14
MAG_238	729047,2	5955011,5	14
MAG_239	729615,69	5955031,50	26
MAG_240	729615,7	5955031,5	26
MAG_241	729615,7	5955031,5	26

Side Sonar Scan Contacts

Contact ID	Easting	Northing	Height	Contact Type
DEB_001	718843,3	5945900,7	5.9x1.5x0.1	Debris
DEB_002	718696,2	5943976,4	3.0x0.3x0.1	Debris
DEB_003	718510,6	5942751,2	1.5x1.7xnmh	Debris
DEB_004	718689,5	5942724,0	3.0x0.5x0.3	Debris

DEB_005	718419,5	5942669,9	0.8x0.3x0.1	Debris
DEB_006	718479,3	5942653,2	2.5x1.2x0.1	Debris
DEB_007	718581,4	5942595,0	5.0x1.3x0.3	Debris
DEB_008	718582,9	5942591,3	4.1x1.0x0.6	Debris
DEB_009	718580,4	5942585,2	1.8x0.5x0.2	Debris
DEB_010	718589,2	5942584,2	5.1x2.4x0.3	Debris
DEB_011	718584,4	5942581,4	4.1x3.3x0.5	Debris
DEB_012	718550,1	5942539,3	1.4x0.8x0.2	Debris
DEB_013	718606,0	5942526,9	2.9x1.0x0.6	Debris
DEB_014	718630,6	5942524,1	2.0x0.5x0.1	Debris
DEB_015	720403,1	5952036,9	1.9x0.7x0.2	Wreck
DEB_016	718395,4	5945567,7	1.0x0.7x0.1	Wreck
DEB_017	718387,7	5945566,4	3.9x0.5x0.1	Debris
DEB_018	718282,9	5944250,1	1.6x0.7x0.3	Debris
DEB_019	718930,1	5944019,3	6.2x1.8x0.4	Debris
DEB_020	718995,4	5943832,0	2.0x0.6x0.2	Debris
DEB_021	718878,1	5943526,3	2.1x0.7x0.2	Debris
DEB_022	718167,1	5942830,6	2.2x0.8x0.2	Debris
DEB_023	718254,5	5942712,2	2.9x1.1x0.1	Debris
DEB_024	718142,1	5942390,0	3.4x1.6x0.8	Debris
DEB_025	718784,2	5941352,3	3.3x1.5xnmh	Debris
DEB_026	718687,6	5941281,5	1.4x0.6x0.1	Debris
SSS_001	720764,04	5955368,29	0,9	Debris
SSS_002	720829,13	5954453,20	0,6	Debris
SSS_003	720820,73	5954342,72	0,6	Object
SSS_004	720821,77	5954270,88	0,5	Object
SSS_005	720880,99	5954431,59	0,6	Object
SSS_006	720892,17	5954300,94	0,8	Object

SSS_007	720893,26	5954290,00	0,7	Object
SSS_008	720905,80	5954298,46	0,9	Object
SSS_009	720945,81	5954410,62	0,6	Object
SSS_010	720952,19	5954327,47	0,6	Object
SSS_011	720959,37	5954364,43	0,6	Object
SSS_012	720960,29	5954352,58	0,7	Object
SSS_013	720968,48	5954364,83	0,6	Object
SSS_014	720988,35	5954348,47	1	Object
SSS_015	720987,94	5954062,19	0,9	Object
SSS_016	721039,97	5954486,91	0,6	Object
SSS_017	720995,11	5954033,91	0,8	Object
SSS_018	721014,90	5954205,53	0,5	Object
SSS_019	721048,07	5954440,97	0,5	Object
SSS_020	721014,60	5954144,86	0,6	Object
SSS_021	721047,79	5954403,65	0,8	Object
SSS_022	721023,57	5954124,07	0,8	Object
SSS_023	721031,84	5954112,67	0,6	Object
SSS_024	721055,06	5954273,47	0,5	Object
SSS_025	721070,04	5954387,96	0,5	Object
SSS_026	721047,65	5954157,24	0,8	Object
SSS_027	721039,23	5954011,52	0,5	Object
SSS_028	721083,56	5954252,55	0,6	Object
SSS_029	721077,94	5954055,23	0,5	Object
SSS_030	721120,45	5954342,55	0,6	Object
SSS_031	721082,86	5953986,73	0,5	Object
SSS_032	721096,70	5954103,85	0,6	Object
SSS_033	721124,20	5954225,46	0,6	Object
SSS_034	721108,47	5954016,11	1	Object

SSS_035	721111,52	5954015,55	0,6	Object
SSS_036	721154,23	5954387,61	0,5	Object
SSS_037	721200,49	5954647,37	0,6	Object
SSS_038	721129,50	5954019,15	0,7	Object
SSS_039	721147,68	5954077,59	0,5	Object
SSS_040	721189,65	5954331,95	0,8	Object
SSS_041	721166,42	5954080,67	0,7	Object
SSS_042	721183,36	5954184,19	0,5	Object
SSS_043	721204,09	5954287,89	0,7	Object
SSS_044	721200,07	5954168,32	0,5	Object
SSS_045	721202,45	5954182,88	0,6	Object
SSS_046	721195,78	5953987,53	0,5	Object
SSS_047	721381,17	5955392,95	1,1	Object
SSS_048	721235,00	5954040,36	0,6	Object
SSS_049	721304,21	5954594,42	1	Object
SSS_050	721246,88	5953990,00	0,7	Object
SSS_051	721321,53	5954595,76	0,9	Object
SSS_052	721290,57	5954297,19	0,6	Object
SSS_053	721343,86	5954472,53	0,5	Object
SSS_054	721373,40	5954458,69	0,5	Object
SSS_055	721419,15	5954712,64	0,7	Object
SSS_056	721408,52	5954529,08	1,3	Object
SSS_057	721395,63	5954262,43	0,6	Object
SSS_058	721395,15	5954252,77	0,7	Object
SSS_059	721458,06	5954747,89	0,9	Object
SSS_060	721444,60	5954037,80	0,6	Object
SSS_061	721455,66	5954048,13	0,5	Object
SSS_062	721554,96	5954666,23	0,8	Object

SSS_063	721517,58	5954248,05	0,6	Object
SSS_064	721523,03	5954218,83	0,7	Object
SSS_065	721637,89	5954907,07	0,7	Object
SSS_066	721648,13	5954914,13	0,5	Object
SSS_067	721571,49	5954203,12	0,5	Object
SSS_068	721656,39	5954932,11	1	Object
SSS_069	721616,00	5954554,46	0,6	Object
SSS_070	721674,18	5955016,59	0,5	Object
SSS_071	721655,25	5954793,46	0,7	Object
SSS_072	721625,01	5954519,17	0,7	Object
SSS_073	721680,77	5955011,05	0,7	Object
SSS_074	721652,06	5954564,38	0,6	Object
SSS_075	721604,57	5954084,46	0,7	Object
SSS_076	721626,38	5954092,91	0,5	Object
SSS_077	721625,38	5954063,72	0,7	Object
SSS_078	721717,09	5954862,86	0,6	Object
SSS_079	721718,05	5954870,34	0,7	Object
SSS_080	721738,42	5955038,28	0,7	Object
SSS_081	721723,22	5954856,19	0,6	Object
SSS_082	721624,62	5953973,00	0,7	Object
SSS_083	721767,69	5955126,00	0,6	Object
SSS_084	721775,98	5955044,12	0,7	Object
SSS_085	721796,01	5955132,17	0,8	Object
SSS_086	721801,77	5955134,43	0,7	Object
SSS_087	721710,89	5954302,92	0,5	Object
SSS_088	721800,27	5955078,78	0,5	Object
SSS_089	721746,76	5954595,75	0,6	Object
SSS_090	721788,65	5954958,66	0,6	Object

SSS_091	721808,34	5955123,30	0,6	Object
SSS_092	721684,49	5953956,43	1,6	Object
SSS_093	721798,86	5954964,39	0,6	Object
SSS_094	721766,62	5954616,90	0,8	Object
SSS_095	721819,68	5955039,44	0,8	Object
SSS_096	721759,40	5954496,67	0,6	Object
SSS_097	721704,59	5954008,27	0,5	Object
SSS_098	721712,63	5954066,90	1	Object
SSS_099	721703,78	5953951,67	0,9	Object
SSS_100	721791,38	5954654,79	0,5	Object
SSS_101	721764,51	5954382,53	0,5	Object
SSS_102	721772,48	5954430,59	0,6	Object
SSS_103	721847,33	5954926,04	0,6	Object
SSS_104	721815,38	5954641,85	0,6	Object
SSS_105	721788,50	5954369,26	0,6	Object
SSS_106	721854,68	5954924,85	0,5	Object
SSS_107	721825,40	5954588,20	0,5	Object
SSS_108	721829,40	5954595,07	0,6	Object
SSS_109	721851,99	5954594,19	0,6	Object
SSS_110	721858,18	5954627,12	0,6	Object
SSS_111	721880,66	5954700,94	0,6	Object
SSS_112	721850,61	5954434,71	0,6	Object
SSS_113	721810,07	5953955,71	0,7	Object
SSS_114	721968,21	5955303,95	0,5	Object
SSS_115	721896,80	5954569,62	0,7	Object
SSS_116	721926,97	5954712,77	0,5	Object
SSS_117	721940,17	5954537,16	0,7	Object
SSS_118	721949,13	5954256,82	0,7	Object

SSS_119	722061,99	5954903,71	0,5	Object
SSS_120	722026,14	5954527,01	0,7	Object
SSS_121	721976,86	5953947,97	0,6	Object
SSS_122	722031,16	5954397,32	0,7	Object
SSS_123	722007,93	5954191,32	0,6	Object
SSS_124	722037,39	5954431,37	0,9	Object
SSS_125	722065,60	5954532,75	0,5	Object
SSS_126	722072,28	5954539,20	0,5	Object
SSS_127	722049,53	5954224,70	0,8	Object
SSS_128	722128,63	5954814,33	0,6	Object
SSS_129	722131,17	5954814,97	0,5	Object
SSS_130	722141,98	5954862,02	0,5	Object
SSS_131	722091,64	5954408,44	0,8	Object
SSS_132	722066,30	5954157,96	0,6	Object
SSS_133	722079,71	5954193,94	0,6	Object
SSS_134	722127,92	5954494,60	0,5	Object
SSS_135	722094,41	5954197,41	0,5	Object
SSS_136	722100,07	5954244,99	0,7	Object
SSS_137	722112,91	5954349,57	1	Object
SSS_138	722112,75	5954276,00	0,7	Object
SSS_139	722119,71	5954332,11	0,6	Object
SSS_140	722168,47	5954646,15	0,5	Object
SSS_141	722175,02	5954701,14	0,7	Object
SSS_142	722117,03	5954180,65	0,5	Object
SSS_143	722162,02	5954289,85	0,6	Object
SSS_144	722256,41	5954766,99	0,8	Object
SSS_145	722258,54	5954554,99	0,6	Object
SSS_146	722266,05	5954620,89	0,5	Object

SSS_147	722266,66	5954547,24	0,6	Object
SSS_148	722348,34	5955174,34	1	Object
SSS_149	722271,90	5954311,52	0,5	Object
SSS_150	722326,41	5954704,99	1,1	Object
SSS_151	722299,30	5954139,59	1	Object
SSS_152	722362,88	5954613,53	0,6	Object
SSS_153	722407,24	5954745,37	0,6	Object
SSS_154	722397,54	5954086,30	0,6	Object
SSS_155	722524,39	5954965,64	0,7	Object
SSS_156	722504,06	5954768,70	0,5	Object
SSS_157	722557,20	5954951,23	0,6	Object
SSS_158	722475,09	5954215,99	0,6	Object
SSS_159	722536,86	5954258,29	0,7	Object
SSS_160	722583,42	5954193,39	0,5	Object
SSS_161	722664,75	5954088,19	0,5	Object
SSS_162	722698,08	5954168,32	0,7	Object
SSS_163	722990,18	5955000,42	0,6	Object
SSS_164	723059,38	5954145,40	0,6	Object
SSS_165	723228,22	5954951,32	0,8	Object
SSS_166	723230,39	5954954,08	0,6	Object
SSS_167	723246,39	5954499,21	0,8	Object
SSS_168	723264,94	5954042,88	0,6	Object
SSS_169	723277,68	5953991,55	0,8	Object
SSS_170	723288,81	5953947,23	0,5	Object
SSS_171	723312,59	5954027,25	0,5	Object
SSS_172	723325,45	5954026,92	0,6	Object
SSS_173	723346,77	5954092,76	0,5	Object
SSS_174	723383,38	5954065,30	0,7	Object

SSS_175	723532,73	5954134,02	0,6	Object
SSS_176	723718,13	5954854,97	0,5	Object
SSS_177	723711,89	5954061,63	0,8	Object
SSS_178	723715,87	5954080,48	0,7	Object
SSS_179	723716,67	5954083,25	0,9	Object
SSS_180	723754,52	5953968,95	1,1	Object
SSS_181	723862,13	5954493,02	1	Object
SSS_182	723808,64	5953913,20	0,8	Object
SSS_183	723809,10	5953901,40	0,7	Object
SSS_184	723849,19	5954109,37	0,6	Object
SSS_185	723845,06	5953991,78	0,6	Object
SSS_186	723854,66	5954067,59	0,5	Object
SSS_187	723853,79	5954050,54	0,5	Object
SSS_188	723862,24	5954111,86	0,5	Object
SSS_189	723857,63	5954050,68	0,6	Object
SSS_190	723852,05	5953876,48	0,6	Object
SSS_191	723881,22	5953902,89	0,7	Object
SSS_192	723905,57	5954059,20	0,6	Object
SSS_193	723903,64	5953887,23	0,6	Object
SSS_194	723926,72	5954041,65	0,5	Object
SSS_195	723960,42	5954035,26	0,5	Object
SSS_196	723975,07	5954068,32	0,5	Object
SSS_197	724277,58	5954747,16	0,6	Object
SSS_198	724476,72	5953817,57	0,5	Object
SSS_199	724644,94	5954411,18	0,5	Object
SSS_200	724661,78	5954539,65	0,6	Object
SSS_201	724579,57	5953602,83	0,7	Object
SSS_202	724731,05	5954433,07	0,7	Object

SSS_203	724642,24	5953636,41	0,6	Object
SSS_204	724766,83	5954450,51	0,6	Object
SSS_205	724783,12	5954517,10	0,6	Object
SSS_206	724778,58	5954449,53	0,6	Object
SSS_207	724778,70	5954349,32	0,6	Object
SSS_208	724780,26	5953558,96	0,5	Object
SSS_209	724942,39	5954328,74	0,7	Object
SSS_210	724989,45	5954393,95	0,6	Object
SSS_211	725009,84	5954374,67	0,7	Object
SSS_212	725048,36	5954528,27	0,6	Object
SSS_213	724985,69	5953718,56	1,2	Object
SSS_214	725096,72	5954515,79	0,5	Object
SSS_215	725124,32	5954241,75	0,6	Object
SSS_216	725134,42	5954237,50	0,6	Object
SSS_217	725144,69	5954278,59	0,6	Object
SSS_218	725092,50	5953770,38	0,5	Object
SSS_219	725150,03	5954266,54	0,5	Object
SSS_220	725152,17	5954277,48	0,5	Object
SSS_221	725178,56	5954225,18	0,5	Object
SSS_222	725124,87	5953745,24	0,6	Object
SSS_223	725115,87	5953501,85	0,5	Object
SSS_224	725172,54	5953894,35	0,5	Object
SSS_225	725246,91	5954420,97	0,7	Object
SSS_226	725261,74	5954467,16	0,7	Object
SSS_227	725212,52	5953937,96	0,6	Object
SSS_228	725244,46	5954123,17	0,5	Object
SSS_229	725262,43	5954046,93	0,6	Object
SSS_230	725276,31	5954136,17	0,5	Object

SSS_231	725288,51	5954240,26	0,6	Object
SSS_232	725285,49	5954061,94	0,9	Object
SSS_233	725327,30	5954221,86	0,7	Object
SSS_234	725336,55	5954215,62	0,8	Object
SSS_235	725341,32	5954252,77	0,6	Object
SSS_236	725346,39	5954204,15	0,5	Object
SSS_237	725390,80	5954497,76	0,6	Object
SSS_238	725361,58	5954030,67	0,7	Object
SSS_239	725387,33	5954238,49	0,5	Object
SSS_240	725361,50	5953844,71	0,8	Object
SSS_241	725428,26	5954348,17	0,6	Object
SSS_242	725473,83	5954428,28	0,7	Object
SSS_243	725407,58	5953805,92	0,7	Object
SSS_244	725447,98	5953818,37	0,8	Object
SSS_245	725500,73	5954077,67	0,6	Object
SSS_246	725469,00	5953705,87	0,7	Object
SSS_247	725502,53	5953777,01	0,6	Object
SSS_248	725503,43	5953676,67	0,5	Object
SSS_249	725549,47	5953801,34	0,7	Object
SSS_250	725568,76	5953790,04	1,1	Object
SSS_251	725654,15	5954532,82	0,5	Object
SSS_252	725650,48	5954214,47	0,5	Object
SSS_253	725671,55	5954313,50	0,6	Object
SSS_254	725663,15	5954214,40	0,6	Object
SSS_255	725649,37	5953785,79	0,6	Object
SSS_256	725831,42	5954364,25	0,5	Object
SSS_257	725785,29	5953766,44	0,6	Object
SSS_258	725827,13	5953653,81	0,6	Object

SSS_259	725928,37	5954476,41	0,6	Object
SSS_260	725965,90	5954322,62	0,7	Object
SSS_261	725997,41	5953887,92	0,5	Object
SSS_262	726052,22	5954102,79	0,5	Object
SSS_263	726057,41	5954141,89	0,6	Object
SSS_264	726125,63	5954417,63	0,7	Object
SSS_265	726114,48	5954190,77	0,6	Object
SSS_266	726107,63	5954125,64	0,7	Object
SSS_267	726119,61	5954110,39	0,6	Object
SSS_268	726091,62	5953851,33	0,7	Object
SSS_269	726190,19	5954548,21	0,6	Object
SSS_270	726173,34	5954150,49	0,5	Object
SSS_271	726253,07	5954394,21	0,9	Object
SSS_272	726319,83	5954354,42	0,5	Object
SSS_273	726386,30	5954389,49	0,7	Object
SSS_274	726412,12	5954380,81	0,6	Object
SSS_275	726385,89	5954146,61	0,9	Object
SSS_276	726544,54	5954494,79	0,5	Object
SSS_277	726502,03	5954104,70	0,8	Object
SSS_278	726506,85	5954107,53	0,7	Object
SSS_279	726592,04	5954486,38	0,7	Object
SSS_280	726742,62	5954423,38	0,7	Object
SSS_281	726870,97	5954279,25	0,6	Object
SSS_282	726958,22	5954177,60	0,6	Object
SSS_283	726989,51	5954175,50	0,7	Object
SSS_284	727046,94	5954189,82	0,5	Object
SSS_285	727104,19	5954382,52	1,1	Object
SSS_286	729697,53	5955104,13	0,6	Object

SSS_287	729774,83	5955004,78	0,7	Object
SSS_288	729767,36	5955100,95	0,5	Object
SSS_289	729791,72	5955056,65	0,9	Object
SSS_290	729990,54	5955191,79	0,6	Object
SSS_291	730162,26	5955230,58	0,5	Object
SSS_292	730317,76	5955207,78	0,6	Object
SSS_293	730309,61	5955222,10	1,2	Object
SSS_294	730297,63	5955291,03	0,5	Object
SSS_295	730324,81	5955286,64	0,5	Object
SSS_296	730359,44	5955287,63	0,7	Object
SSS_297	730418,89	5955242,55	0,5	Object
SSS_298	730417,60	5955276,24	0,6	Object
SSS_299	730463,81	5955245,45	0,5	Object
SSS_300	730506,71	5955235,50	0,5	Object
SSS_301	730516,10	5955237,56	0,5	Object
SSS_302	730541,92	5955229,90	0,9	Object
SSS_303	730556,17	5955284,38	0,6	Object
SSS_304	730578,58	5955257,66	0,9	Object
SSS_305	730574,39	5955355,60	0,5	Object
SSS_306	721419,2	5954712,6	0,7	Object
SSS_307	721408,5	5954529,1	1,3	Object
SSS_308	721458,1	5954747,9	0,9	Object
SSS_309	721555,0	5954666,2	0,8	Object
SSS_310	721616,0	5954554,5	0,6	Object
SSS_311	721655,2	5954793,5	0,7	Object
SSS_312	721625,0	5954519,2	0,7	Object
SSS_313	721652,1	5954564,4	0,6	Object
SSS_314	721746,8	5954595,7	0,6	Object

SSS_315	721766,6	5954616,9	0,8	Object
SSS_316	721759,4	5954496,7	0,6	Object
SSS_317	721791,4	5954654,8	0,5	Object
SSS_318	721772,5	5954430,6	0,6	Object
SSS_319	721815,4	5954641,9	0,6	Object
SSS_320	721825,4	5954588,2	0,5	Object
SSS_321	721829,4	5954595,1	0,6	Object
SSS_322	721852,0	5954594,2	0,6	Object
SSS_323	721858,2	5954627,1	0,6	Object
SSS_324	721880,7	5954700,9	0,6	Object
SSS_325	721850,6	5954434,7	0,6	Object
SSS_326	721896,8	5954569,6	0,7	Object
SSS_327	721927,0	5954712,8	0,5	Object
SSS_328	721940,2	5954537,2	0,7	Object
SSS_329	722026,1	5954527,0	0,7	Object
SSS_330	722037,4	5954431,4	0,9	Object
SSS_331	722065,6	5954532,7	0,5	Object
SSS_332	722072,3	5954539,2	0,5	Object
SSS_333	722091,6	5954408,4	0,8	Object
SSS_334	722127,9	5954494,6	0,5	Object
SSS_335	722168,5	5954646,2	0,5	Object
SSS_336	722175,0	5954701,1	0,7	Object
SSS_337	722256,4	5954767,0	0,8	Object
SSS_338	722258,5	5954555,0	0,6	Object
SSS_339	722266,1	5954620,9	0,5	Object
SSS_340	722266,7	5954547,2	0,6	Object
SSS_341	722326,4	5954705,0	1,1	Object
SSS_342	722362,9	5954613,5	0,6	Object

SSS_343	722407,2	5954745,4	0,6	Object
SSS_344	723246,4	5954499,2	0,8	Object
SSS_345	723862,1	5954493,0	1	Object
SSS_346	724644,9	5954411,2	0,5	Object
SSS_347	724731,1	5954433,1	0,7	Object
SSS_348	724766,8	5954450,5	0,6	Object
SSS_349	724778,6	5954449,5	0,6	Object
SSS_350	724778,7	5954349,3	0,6	Object
SSS_351	724942,4	5954328,7	0,7	Object
SSS_352	724989,4	5954394,0	0,6	Object
SSS_353	725009,8	5954374,7	0,7	Object
SSS_354	725124,3	5954241,8	0,6	Object
SSS_355	725134,4	5954237,5	0,6	Object
SSS_356	725144,7	5954278,6	0,6	Object
SSS_357	725150,0	5954266,5	0,5	Object
SSS_358	725152,2	5954277,5	0,5	Object
SSS_359	725178,6	5954225,2	0,5	Object
SSS_360	725246,9	5954421,0	0,7	Object
SSS_361	725244,5	5954123,2	0,5	Object
SSS_362	725262,4	5954046,9	0,6	Object
SSS_363	725276,3	5954136,2	0,5	Object
SSS_364	725288,5	5954240,3	0,6	Object
SSS_365	725285,5	5954061,9	0,9	Object
SSS_366	725327,3	5954221,9	0,7	Object
SSS_367	725336,5	5954215,6	0,8	Object
SSS_368	725341,3	5954252,8	0,6	Object
SSS_369	725346,4	5954204,1	0,5	Object
SSS_370	725361,6	5954030,7	0,7	Object

SSS_371	725387,3	5954238,5	0,5	Object
SSS_372	725428,3	5954348,2	0,6	Object
SSS_373	725500,7	5954077,7	0,6	Object
SSS_374	725650,5	5954214,5	0,5	Object
SSS_375	725671,5	5954313,5	0,6	Object
SSS_376	725663,1	5954214,4	0,6	Object
SSS_377	725831,4	5954364,2	0,5	Object
SSS_378	725965,9	5954322,6	0,7	Object
SSS_379	726052,2	5954102,8	0,5	Object
SSS_380	726057,4	5954141,9	0,6	Object
SSS_381	726114,5	5954190,8	0,6	Object
SSS_382	726107,6	5954125,6	0,7	Object
SSS_383	726119,6	5954110,4	0,6	Object
SSS_384	726173,3	5954150,5	0,5	Object
SSS_385	726385,9	5954146,6	0,9	Object
SSS_386	726502,0	5954104,7	0,8	Object
SSS_387	726506,9	5954107,5	0,7	Object
SSS_388	726871,0	5954279,2	0,6	Object
SSS_389	726958,2	5954177,6	0,6	Object
SSS_390	726989,5	5954175,5	0,7	Object
SSS_391	727046,9	5954189,8	0,5	Object
SSS_392	727104,2	5954382,5	1,1	Object
SSS_393	729697,5	5955104,1	0,6	Object
SSS_394	729774,8	5955004,8	0,7	Object
SSS_395	729767,4	5955101,0	0,5	Object
SSS_396	729791,7	5955056,7	0,9	Object
SSS_397	729990,5	5955191,8	0,6	Object
SSS_398	721343,9	5954472,5	0,5	Object

SSS_399	721373,4	5954458,7	0,5	Object
SSS_400	721517,6	5954248,1	0,6	Object
SSS_401	721290,6	5954297,2	0,6	Object
SSS_402	721395,6	5954262,4	0,6	Object
SSS_403	721571,5	5954203,1	0,5	Object
SSS_404	721523,0	5954218,8	0,7	Object
SSS_405	721395,2	5954252,8	0,7	Object
SSS_406	721626,4	5954092,9	0,5	Object
SSS_407	721604,6	5954084,5	0,7	Object
SSS_408	721455,7	5954048,1	0,5	Object
SSS_409	721444,6	5954037,8	0,6	Object
SSS_410	721235,0	5954040,4	0,6	Object
SSS_411	721246,9	5953990,0	0,7	Object
SSS_412	721195,8	5953987,5	0,5	Object
SSS_413	721388,2	5953864,3	0,6	Object
SSS_414	721246,8	5953887,4	0,6	Object
SSS_415	721227,5	5953868,5	0,7	Object
SSS_416	721343,0	5953829,2	0,5	Object
SSS_417	721224,7	5953846,8	0,6	Object
SSS_418	721379,4	5953792,7	0,6	Object
SSS_419	721392,0	5953769,8	0,7	Object
SSS_420	721261,2	5953798,9	0,8	Object
SSS_421	721418,9	5953687,4	0,6	Object
SSS_422	721338,8	5953691,8	0,8	Object
SSS_423	721339,8	5953688,0	0,8	Object
SSS_424	721351,0	5953668,2	0,8	Object
SSS_425	721357,9	5953583,8	0,5	Object
SSS_426	721410,7	5953535,3	0,6	Object

SSS_427	718503,9	5942263,9	0,8	Object
SSS_428	720988,4	5954348,5	1	Object
SSS_429	721040	5954486,9	0,6	Object
SSS_430	721048,1	5954441	0,5	Object
SSS_431	721047,8	5954403,6	0,8	Object
SSS_432	721055,1	5954273,5	0,5	Object
SSS_433	721070	5954388	0,5	Object
SSS_434	721083,6	5954252,5	0,6	Object
SSS_435	721120,5	5954342,5	0,6	Object
SSS_436	721124,2	5954225,5	0,6	Object
SSS_437	721154,2	5954387,6	0,5	Object
SSS_438	721200,5	5954647,4	0,6	Object
SSS_439	721189,7	5954332	0,8	Object
SSS_440	721204,1	5954287,9	0,7	Object
SSS_441	721304,2	5954594,4	1	Object
SSS_442	721321,5	5954595,8	0,9	Object
SSS_443	721290,6	5954297,2	0,6	Object
SSS_444	721343,9	5954472,5	0,5	Object
SSS_445	721373,4	5954458,7	0,5	Object
SSS_446	721419,2	5954712,6	0,7	Object
SSS_447	721408,5	5954529,1	1,3	Object
SSS_448	721395,6	5954262,4	0,6	Object
SSS_449	721395,2	5954252,8	0,7	Object
SSS_450	721458,1	5954747,9	0,9	Object
SSS_451	721555	5954666,2	0,8	Object
SSS_452	721517,6	5954248,1	0,6	Object
SSS_453	721523	5954218,8	0,7	Object
SSS_454	721637,9	5954907,1	0,7	Object

SSS_455	721648,1	5954914,1	0,5	Object
SSS_456	721571,5	5954203,1	0,5	Object
SSS_457	721656,4	5954932,1	1	Object
SSS_458	721616	5954554,5	0,6	Object
SSS_459	721674,2	5955016,6	0,5	Object
SSS_460	721655,2	5954793,5	0,7	Object
SSS_461	721625	5954519,2	0,7	Object
SSS_462	721680,8	5955011	0,7	Object
SSS_463	721652,1	5954564,4	0,6	Object
SSS_464	721717,1	5954862,9	0,6	Object
SSS_465	721718,1	5954870,3	0,7	Object
SSS_466	721738,4	5955038,3	0,7	Object
SSS_467	721723,2	5954856,2	0,6	Object
SSS_468	721767,7	5955126	0,6	Object
SSS_469	721776	5955044,1	0,7	Object
SSS_470	721710,9	5954302,9	0,5	Object
SSS_471	721800,3	5955078,8	0,5	Object
SSS_472	721746,8	5954595,7	0,6	Object
SSS_473	721788,7	5954958,7	0,6	Object
SSS_474	721808,3	5955123,3	0,6	Object
SSS_475	721798,9	5954964,4	0,6	Object
SSS_476	721766,6	5954616,9	0,8	Object
SSS_477	721819,7	5955039,4	0,8	Object
SSS_478	721759,4	5954496,7	0,6	Object
SSS_479	721791,4	5954654,8	0,5	Object
SSS_480	721764,5	5954382,5	0,5	Object
SSS_481	721772,5	5954430,6	0,6	Object
SSS_482	721847,3	5954926	0,6	Object

SSS_483	721815,4	5954641,9	0,6	Object
SSS_484	721788,5	5954369,3	0,6	Object
SSS_485	721854,7	5954924,8	0,5	Object
SSS_486	721825,4	5954588,2	0,5	Object
SSS_487	721829,4	5954595,1	0,6	Object
SSS_488	721852	5954594,2	0,6	Object
SSS_489	721858,2	5954627,1	0,6	Object
SSS_490	721880,7	5954700,9	0,6	Object
SSS_491	721850,6	5954434,7	0,6	Object
SSS_492	721896,8	5954569,6	0,7	Object
SSS_493	721927	5954712,8	0,5	Object
SSS_494	721940,2	5954537,2	0,7	Object
SSS_495	721949,1	5954256,8	0,7	Object
SSS_496	722062	5954903,7	0,5	Object
SSS_497	722026,1	5954527	0,7	Object
SSS_498	722031,2	5954397,3	0,7	Object
SSS_499	722007,9	5954191,3	0,6	Object
SSS_500	722037,4	5954431,4	0,9	Object
SSS_501	722065,6	5954532,7	0,5	Object
SSS_502	722072,3	5954539,2	0,5	Object
SSS_503	722049,5	5954224,7	0,8	Object
SSS_504	722128,6	5954814,3	0,6	Object
SSS_505	722131,2	5954815	0,5	Object
SSS_506	722142	5954862	0,5	Object
SSS_507	722091,6	5954408,4	0,8	Object
SSS_508	722066,3	5954158	0,6	Object
SSS_509	722079,7	5954193,9	0,6	Object
SSS_510	722127,9	5954494,6	0,5	Object

SSS_511	722094,4	5954197,4	0,5	Object
SSS_512	722100,1	5954245	0,7	Object
SSS_513	722112,9	5954349,6	1	Object
SSS_514	722112,7	5954276	0,7	Object
SSS_515	722119,7	5954332,1	0,6	Object
SSS_516	722168,5	5954646,2	0,5	Object
SSS_517	722175	5954701,1	0,7	Object
SSS_518	722117	5954180,7	0,5	Object
SSS_519	722162	5954289,9	0,6	Object
SSS_520	722256,4	5954767	0,8	Object
SSS_521	722258,5	5954555	0,6	Object
SSS_522	722266,1	5954620,9	0,5	Object
SSS_523	722266,7	5954547,2	0,6	Object
SSS_524	722271,9	5954311,5	0,5	Object
SSS_525	722326,4	5954705	1,1	Object
SSS_526	722299,3	5954139,6	1	Object
SSS_527	722362,9	5954613,5	0,6	Object
SSS_528	722407,2	5954745,4	0,6	Object
SSS_529	722397,5	5954086,3	0,6	Object
SSS_530	722524,4	5954965,6	0,7	Object
SSS_531	722504,1	5954768,7	0,5	Object
SSS_532	722557,2	5954951,2	0,6	Object
SSS_533	722475,1	5954216	0,6	Object
SSS_534	722536,9	5954258,3	0,7	Object
SSS_535	722583,4	5954193,4	0,5	Object
SSS_536	722664,8	5954088,2	0,5	Object
SSS_537	722698,1	5954168,3	0,7	Object
SSS_538	723059,4	5954145,4	0,6	Object

SSS_539	723228,2	5954951,3	0,8	Object
SSS_540	723230,4	5954954,1	0,6	Object
SSS_541	723246,4	5954499,2	0,8	Object
SSS_542	723264,9	5954042,9	0,6	Object
SSS_543	723277,7	5953991,5	0,8	Object
SSS_544	723312,6	5954027,2	0,5	Object
SSS_545	723325,5	5954026,9	0,6	Object
SSS_546	723346,8	5954092,8	0,5	Object
SSS_547	723383,4	5954065,3	0,7	Object
SSS_548	723532,7	5954134	0,6	Object
SSS_549	723718,1	5954855	0,5	Object
SSS_550	723711,9	5954061,6	0,8	Object
SSS_551	723715,9	5954080,5	0,7	Object
SSS_552	723716,7	5954083,2	0,9	Object
SSS_553	723754,5	5953969	1,1	Object
SSS_554	723862,1	5954493	1	Object
SSS_555	723808,6	5953913,2	0,8	Object
SSS_556	723809,1	5953901,4	0,7	Object
SSS_557	723849,2	5954109,4	0,6	Object
SSS_558	723845,1	5953991,8	0,6	Object
SSS_559	723854,7	5954067,6	0,5	Object
SSS_560	723853,8	5954050,5	0,5	Object
SSS_561	723862,2	5954111,9	0,5	Object
SSS_562	723857,6	5954050,7	0,6	Object
SSS_563	723881,2	5953902,9	0,7	Object
SSS_564	723905,6	5954059,2	0,6	Object
SSS_565	723903,6	5953887,2	0,6	Object
SSS_566	723926,7	5954041,6	0,5	Object

SSS_567	723960,4	5954035,3	0,5	Object
SSS_568	723975,1	5954068,3	0,5	Object
SSS_569	724277,6	5954747,2	0,6	Object
SSS_570	724644,9	5954411,2	0,5	Object
SSS_571	724661,8	5954539,6	0,6	Object
SSS_572	724731,1	5954433,1	0,7	Object
SSS_573	724766,8	5954450,5	0,6	Object
SSS_574	724783,1	5954517,1	0,6	Object
SSS_575	724778,6	5954449,5	0,6	Object
SSS_576	724778,7	5954349,3	0,6	Object
SSS_577	724942,4	5954328,7	0,7	Object
SSS_578	724989,4	5954394	0,6	Object
SSS_579	725009,8	5954374,7	0,7	Object
SSS_580	725048,4	5954528,3	0,6	Object
SSS_581	725096,7	5954515,8	0,5	Object
SSS_582	725124,3	5954241,8	0,6	Object
SSS_583	725134,4	5954237,5	0,6	Object
SSS_584	725144,7	5954278,6	0,6	Object
SSS_585	725092,5	5953770,4	0,5	Object
SSS_586	725150	5954266,5	0,5	Object
SSS_587	725152,2	5954277,5	0,5	Object
SSS_588	725178,6	5954225,2	0,5	Object
SSS_589	725172,5	5953894,4	0,5	Object
SSS_590	725246,9	5954421	0,7	Object
SSS_591	725261,7	5954467,2	0,7	Object
SSS_592	725212,5	5953938	0,6	Object
SSS_593	725244,5	5954123,2	0,5	Object
SSS_594	725262,4	5954046,9	0,6	Object

SSS_595	725276,3	5954136,2	0,5	Object
SSS_596	725288,5	5954240,3	0,6	Object
SSS_597	725285,5	5954061,9	0,9	Object
SSS_598	725327,3	5954221,9	0,7	Object
SSS_599	725336,5	5954215,6	0,8	Object
SSS_600	725341,3	5954252,8	0,6	Object
SSS_601	725346,4	5954204,1	0,5	Object
SSS_602	725390,8	5954497,8	0,6	Object
SSS_603	725361,6	5954030,7	0,7	Object
SSS_604	725387,3	5954238,5	0,5	Object
SSS_605	725361,5	5953844,7	0,8	Object
SSS_606	725428,3	5954348,2	0,6	Object
SSS_607	725473,8	5954428,3	0,7	Object
SSS_608	725407,6	5953805,9	0,7	Object
SSS_609	725448	5953818,4	0,8	Object
SSS_610	725500,7	5954077,7	0,6	Object
SSS_611	725502,5	5953777	0,6	Object
SSS_612	725549,5	5953801,3	0,7	Object
SSS_613	725568,8	5953790	1,1	Object
SSS_614	725654,1	5954532,8	0,5	Object
SSS_615	725650,5	5954214,5	0,5	Object
SSS_616	725671,5	5954313,5	0,6	Object
SSS_617	725663,1	5954214,4	0,6	Object
SSS_618	725649,4	5953785,8	0,6	Object
SSS_619	725831,4	5954364,2	0,5	Object
SSS_620	725785,3	5953766,4	0,6	Object
SSS_621	725928,4	5954476,4	0,6	Object
SSS_622	725965,9	5954322,6	0,7	Object

SSS_623	725997,4	5953887,9	0,5	Object
SSS_624	726052,2	5954102,8	0,5	Object
SSS_625	726057,4	5954141,9	0,6	Object
SSS_626	726125,6	5954417,6	0,7	Object
SSS_627	726114,5	5954190,8	0,6	Object
SSS_628	726107,6	5954125,6	0,7	Object
SSS_629	726119,6	5954110,4	0,6	Object
SSS_630	726091,6	5953851,3	0,7	Object
SSS_631	726190,2	5954548,2	0,6	Object
SSS_632	726173,3	5954150,5	0,5	Object
SSS_633	726253,1	5954394,2	0,9	Object
SSS_634	726319,8	5954354,4	0,5	Object
SSS_635	726386,3	5954389,5	0,7	Object
SSS_636	726412,1	5954380,8	0,6	Object
SSS_637	726385,9	5954146,6	0,9	Object
SSS_638	726544,5	5954494,8	0,5	Object
SSS_639	726502	5954104,7	0,8	Object
SSS_640	726506,9	5954107,5	0,7	Object
SSS_641	726592	5954486,4	0,7	Object
SSS_642	726742,6	5954423,4	0,7	Object
SSS_643	726871	5954279,2	0,6	Object
SSS_644	726958,2	5954177,6	0,6	Object
SSS_645	726989,5	5954175,5	0,7	Object
SSS_646	727046,9	5954189,8	0,5	Object
SSS_647	727104,2	5954382,5	1,1	Object
SSS_648	729697,5	5955104,1	0,6	Object
SSS_649	729774,8	5955004,8	0,7	Object
SSS_650	729767,4	5955101	0,5	Object

SSS_651	729791,7	5955056,7	0,9	Object
SSS_652	729990,5	5955191,8	0,6	Object
SSS_653	730162,3	5955230,6	0,5	Object
SSS_654	730317,8	5955207,8	0,6	Object
SSS_655	730309,6	5955222,1	1,2	Object
SSS_656	730297,6	5955291	0,5	Object
SSS_657	730324,8	5955286,6	0,5	Object
SSS_658	730359,4	5955287,6	0,7	Object
SSS_659	730418,9	5955242,5	0,5	Object
SSS_660	730417,6	5955276,2	0,6	Object
SSS_661	730463,8	5955245,5	0,5	Object
SSS_662	730506,7	5955235,5	0,5	Object
SSS_663	730516,1	5955237,6	0,5	Object
SSS_664	721968,2	5955304,0	0,5	Object
SSS_665	721381,2	5955392,9	1,1	Object
SSS_666	721801,8	5955134,4	0,7	Object
SSS_667	721796,0	5955132,2	0,8	Object
SSS_668	721808,3	5955123,3	0,6	Object
SSS_669	721767,7	5955126,0	0,6	Object
SSS_670	721800,3	5955078,8	0,5	Object
SSS_671	721819,7	5955039,4	0,8	Object
SSS_672	721776,0	5955044,1	0,7	Object
SSS_673	721738,4	5955038,3	0,7	Object
SSS_674	722062,0	5954903,7	0,5	Object
SSS_675	721674,2	5955016,6	0,5	Object
SSS_676	722142,0	5954862,0	0,5	Object
SSS_677	721680,8	5955011,0	0,7	Object
SSS_678	721798,9	5954964,4	0,6	Object

SSS_679	721788,7	5954958,7	0,6	Object
SSS_680	721854,7	5954924,8	0,5	Object
SSS_681	721847,3	5954926,0	0,6	Object
SSS_682	722131,2	5954815,0	0,5	Object
SSS_683	722128,6	5954814,3	0,6	Object
SSS_684	721656,4	5954932,1	1	Object
SSS_685	721648,1	5954914,1	0,5	Object
SSS_686	721637,9	5954907,1	0,7	Object
SSS_687	721718,1	5954870,3	0,7	Object
SSS_688	721717,1	5954862,9	0,6	Object
SSS_689	721723,2	5954856,2	0,6	Object
SSS_690	722031,2	5954397,3	0,7	Object
SSS_691	721200,5	5954647,4	0,6	Object
SSS_692	721321,5	5954595,8	0,9	Object
SSS_693	721304,2	5954594,4	1	Object
SSS_694	721764,5	5954382,5	0,5	Object
SSS_695	721788,5	5954369,3	0,6	Object
SSS_696	721949,1	5954256,8	0,7	Object
SSS_697	721710,9	5954302,9	0,5	Object
SSS_698	721040,0	5954486,9	0,6	Object
SSS_699	721048,1	5954441,0	0,5	Object
SSS_700	721154,2	5954387,6	0,5	Object
SSS_701	721047,8	5954403,6	0,8	Object
SSS_702	721070,0	5954388,0	0,5	Object
SSS_703	721189,7	5954332,0	0,8	Object
SSS_704	721120,5	5954342,5	0,6	Object
SSS_705	721204,1	5954287,9	0,7	Object
SSS_706	720988,4	5954348,5	1	Object

SSS_707	721712,6	5954066,9	1	Object
SSS_708	721055,1	5954273,5	0,5	Object
SSS_709	721083,6	5954252,5	0,6	Object
SSS_710	721625,4	5954063,7	0,7	Object
SSS_711	721124,2	5954225,5	0,6	Object
SSS_712	721202,4	5954182,9	0,6	Object
SSS_713	721183,4	5954184,2	0,5	Object
SSS_714	721704,6	5954008,3	0,5	Object
SSS_715	721200,1	5954168,3	0,5	Object
SSS_716	721810,1	5953955,7	0,7	Object
SSS_717	721014,9	5954205,5	0,5	Object
SSS_718	721703,8	5953951,7	0,9	Object
SSS_719	721684,5	5953956,4	1,6	Object
SSS_720	721624,6	5953973,0	0,7	Object
SSS_721	721047,7	5954157,2	0,8	Object
SSS_722	721014,6	5954144,9	0,6	Object
SSS_723	721096,7	5954103,8	0,6	Object
SSS_724	721166,4	5954080,7	0,7	Object
SSS_725	721023,6	5954124,1	0,8	Object
SSS_726	721147,7	5954077,6	0,5	Object
SSS_727	721031,8	5954112,7	0,6	Object
SSS_728	721077,9	5954055,2	0,5	Object
SSS_729	721129,5	5954019,2	0,7	Object
SSS_730	720987,9	5954062,2	0,9	Object
SSS_731	721567,9	5953867,9	0,6	Object
SSS_732	721111,5	5954015,6	0,6	Object
SSS_733	721108,5	5954016,1	1	Object
SSS_734	720995,1	5954033,9	0,8	Object

SSS_735	721039,2	5954011,5	0,5	Object
SSS_736	721082,9	5953986,7	0,5	Object
SSS_737	721072,1	5953895,1	0,6	Object
SSS_738	720316,0	5950031,5	0,9	Object
SSS_739	720114,5	5948971,1	0,8	Object
SSS_740	719671,1	5947933,0	0,6	Object
SSS_741	718851,9	5942574,8	0,5	Object
SSS_742	722065,602	5954532,748	0,5	Object
SSS_743	721847,333	5954926,036	0,6	Object
SSS_744	721718,052	5954870,335	0,7	Object
SSS_745	721723,219	5954856,189	0,6	Object
SSS_746	721523,033	5954218,829	0,7	Object
SSS_747	721517,576	5954248,052	0,6	Object
SSS_748	721717,093	5954862,856	0,6	Object
SSS_749	721395,154	5954252,774	0,7	Object
SSS_750	721395,633	5954262,425	0,6	Object
SSS_751	721321,532	5954595,757	0,9	Object
SSS_752	721738,417	5955038,276	0,7	Object
SSS_753	721767,685	5955125,998	0,6	Object
SSS_754	721800,267	5955078,779	0,5	Object
SSS_755	721200,485	5954647,373	0,6	Object
SSS_756	721710,894	5954302,916	0,5	Object
SSS_757	721759,398	5954496,665	0,6	Object
SSS_758	721815,378	5954641,854	0,6	Object
SSS_759	721940,171	5954537,155	0,7	Object
SSS_760	722072,284	5954539,197	0,5	Object
SSS_761	721571,489	5954203,118	0,5	Object
SSS_762	722031,163	5954397,323	0,7	Object

SSS_763	721764,507	5954382,525	0,5	Object
SSS_764	721788,498	5954369,264	0,6	Object
SSS_765	722112,914	5954349,566	1	Object
SSS_766	721656,392	5954932,107	1	Object
SSS_767	721788,653	5954958,655	0,6	Object
SSS_768	721896,799	5954569,624	0,7	Object
SSS_769	721819,678	5955039,442	0,8	Object
SSS_770	721775,982	5955044,12	0,7	Object
SSS_771	721808,335	5955123,298	0,6	Object
SSS_772	721458,055	5954747,893	0,9	Object
SSS_773	721880,655	5954700,943	0,6	Object
SSS_774	721554,962	5954666,225	0,8	Object
SSS_775	722119,708	5954332,113	0,6	Object
SSS_776	721637,887	5954907,072	0,7	Object
SSS_777	721625,005	5954519,167	0,7	Object
SSS_778	721419,153	5954712,644	0,7	Object
SSS_779	721746,755	5954595,746	0,6	Object
SSS_780	721766,615	5954616,901	0,8	Object
SSS_781	721825,401	5954588,196	0,5	Object
SSS_782	721851,994	5954594,191	0,6	Object
SSS_783	721854,677	5954924,845	0,5	Object
SSS_784	722037,385	5954431,371	0,9	Object
SSS_785	722026,142	5954527,01	0,7	Object
SSS_786	721290,573	5954297,188	0,6	Object
SSS_787	721343,864	5954472,532	0,5	Object
SSS_788	721373,402	5954458,692	0,5	Object
SSS_789	721408,521	5954529,082	1,3	Object
SSS_790	721829,398	5954595,074	0,6	Object

SSS_791	721652,063	5954564,38	0,6	Object
SSS_792	721791,384	5954654,785	0,5	Object
SSS_793	721798,859	5954964,393	0,6	Object
SSS_794	721648,134	5954914,129	0,5	Object
SSS_795	721796,007	5955132,171	0,8	Object
SSS_796	721655,249	5954793,462	0,7	Object
SSS_797	721304,212	5954594,415	1	Object
SSS_798	721674,177	5955016,59	0,5	Object
SSS_799	721949,132	5954256,82	0,7	Object
SSS_800	721850,605	5954434,709	0,6	Object
SSS_801	721680,772	5955011,048	0,7	Object
SSS_802	721858,183	5954627,117	0,6	Object
WRECK_001	720537,7	5952510,7	19.1x12.9x0.2	Wreck
WRECK_002	720467,1	5952450,6	40.1x12.8x1.1	Wreck

B. Directional wave scatter

Monthly and All-year Joint Frequency Distributions of Hs and Mdir

All-Year

Significant Wave Height [m]	N	NE	E	SE	S	SW	W	NW	Total %
Total	22.27	10.00	2.97	1.81	1.75	3.29	17.18	40.73	100.00
> 4.00								<0.01	<0.01
3.75 – 4.00	<0.01							0.14	0.14
3.50 – 3.75	0.03							0.49	0.52
3.25 – 3.50	0.05							0.91	0.96
3.00 – 3.25	0.11						<0.01	1.31	1.42
2.75 – 3.00	0.18						<0.01	1.39	1.58
2.50 – 2.75	0.26						0.04	1.40	1.71
2.25 – 2.50	0.32	<0.01					0.12	1.78	2.22
2.00 – 2.25	0.43	0.03				<0.01	0.32	2.18	2.97
1.75 – 2.00	0.65	0.06				<0.01	0.57	2.70	3.99
1.50 – 1.75	1.16	0.22	0.01	<0.01	<0.01	0.04	1.23	3.48	6.14
1.25 – 1.50	1.94	0.54	0.04	<0.01	0.01	0.11	2.16	4.51	9.32
1.00 – 1.25	3.04	1.15	0.16	0.03	0.08	0.37	2.91	5.46	13.20
0.75 – 1.00	4.71	1.99	0.49	0.21	0.33	0.80	3.38	5.88	17.78
0.50 – 0.75	5.46	2.92	1.06	0.67	0.68	1.07	3.70	5.28	20.83
0.25 – 0.50	3.53	2.64	1.01	0.75	0.57	0.78	2.39	3.43	15.09
0.00 – 0.25	0.41	0.46	0.19	0.15	0.07	0.12	0.34	0.39	2.13

Significant Wave Height [m]	Exceed %
3.75	0.14
3.50	0.67
3.25	1.63
3.00	3.05
2.75	4.63
2.50	6.34
2.25	8.56
2.00	11.53
1.75	15.51
1.50	21.65
1.25	30.97
1.00	44.18
0.75	61.95
0.50	82.78
0.25	97.87

Mean Wave Direction [°T From]

All-Year

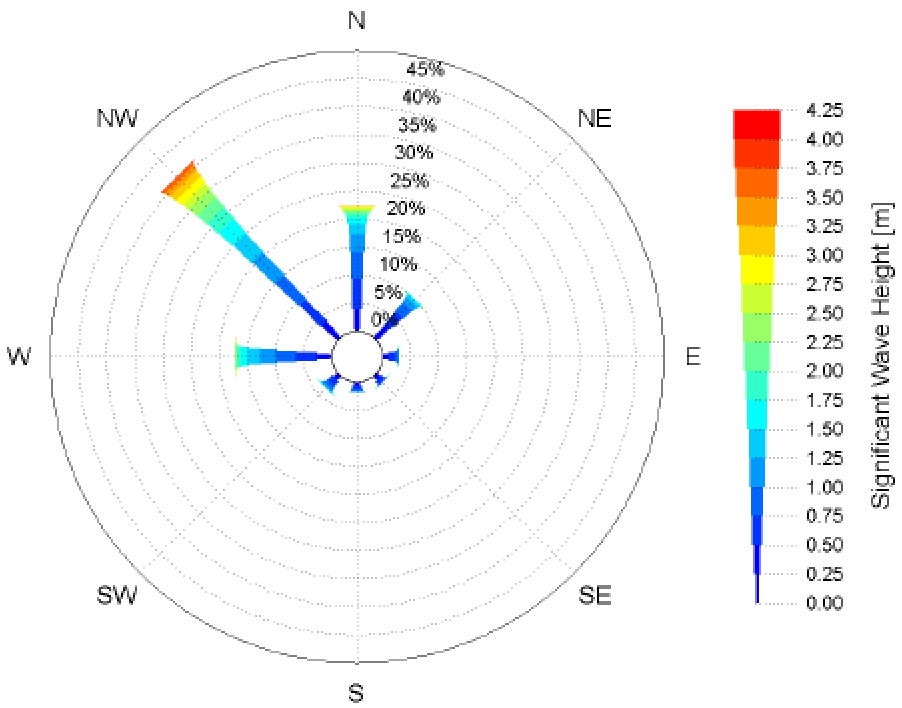


Figure B-1: Near platform wave scatter [ref II]

All-Year

Current Speed at 0m [m/s]	N	NE	E	SE	S	SW	W	NW	Total %	Exceed %
Total	2.05	3.60	44.83	1.01	0.30	0.60	41.81	5.80	100.00	
1.10			<0.01						<0.01	
1.05			<0.01				<0.01		<0.01	
1.00			0.02				<0.01		0.02	0.03
0.95			0.06				<0.01		0.06	0.10
0.90			0.16				<0.01		0.17	0.27
0.85			0.55				0.02		0.57	0.84
0.80			1.57				0.04		1.62	2.46
0.75			2.95				0.09		3.04	5.50
0.70			3.87				0.25		4.12	9.62
0.65			4.41				1.14		5.55	15.17
0.60			4.63				2.78		7.41	22.58
0.55			4.25				4.09	<0.01	8.34	30.93
0.50		<0.01	3.72	<0.01		<0.01	4.87	<0.01	8.59	39.52
0.45		<0.01	3.26	<0.01			5.18	0.02	8.46	47.98
0.40		<0.01	2.91	<0.01		<0.01	5.04	0.06	8.02	56.01
0.35		0.02	2.62	<0.01		<0.01	4.55	0.14	7.33	63.34
0.30	<0.01	0.05	2.38	0.02		<0.01	3.89	0.31	6.65	69.99
0.25	0.01	0.14	2.22	0.04	<0.01	<0.01	3.12	0.56	6.09	76.08
0.20	0.05	0.36	1.92	0.07	<0.01	0.02	2.42	0.94	5.78	81.86
0.15	0.18	0.82	1.48	0.12	<0.01	0.04	1.78	1.34	5.77	87.63
0.10	0.65	1.26	1.00	0.20	0.03	0.09	1.31	1.46	5.99	93.61
0.05	0.96	0.76	0.62	0.32	0.09	0.20	0.89	0.75	4.60	98.21
0.00	0.19	0.19	0.24	0.23	0.17	0.24	0.32	0.21	1.79	

Current Direction at 0m [°T Towards]

All-Year

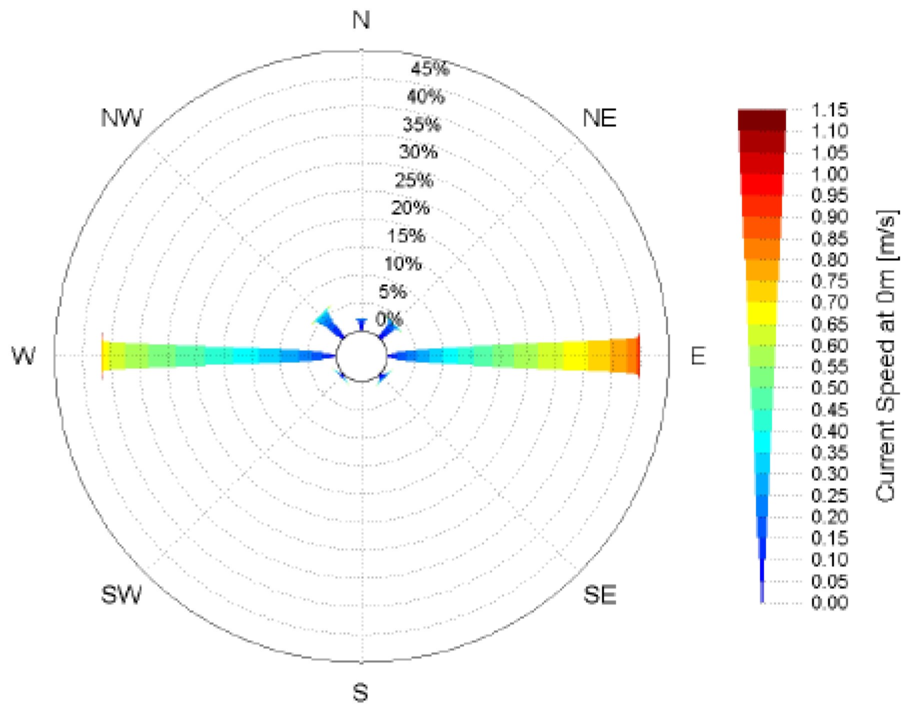
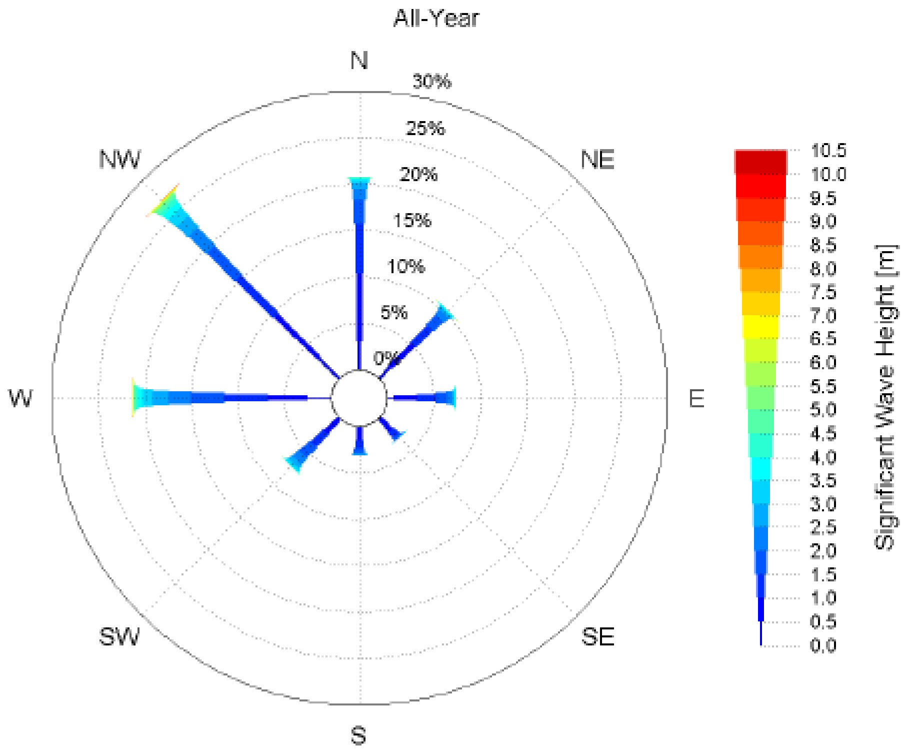


Figure B-2: Near platform current scatter [ref II]

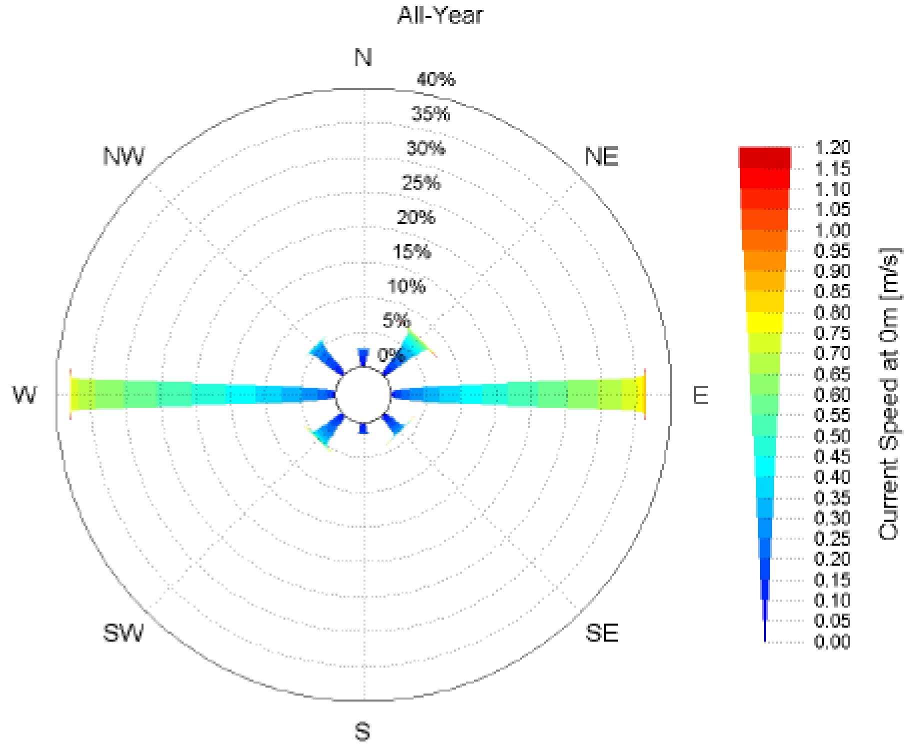


All-Year

Significant Wave Height [m]	N	NE	E	SE	S	SW	W	NW	Total %	Exceed %
Total	20.79	10.32	7.24	2.97	3.14	7.30	21.26	26.98	100.00	
10.0–10.5								<0.01	<0.01	
9.5–10.0										
9.0–9.5										
8.5–9.0								<0.01	<0.01	
8.0–8.5	<0.01							0.02	0.02	0.02
7.5–8.0	<0.01							0.01	0.01	0.04
7.0–7.5	<0.01						<0.01	0.02	0.03	0.06
6.5–7.0	<0.01						<0.01	0.04	0.05	0.11
6.0–6.5	0.01						<0.01	0.05	0.07	0.19
5.5–6.0	0.02	<0.01					0.02	0.11	0.15	0.34
5.0–5.5	0.04	<0.01					0.06	0.19	0.29	0.63
4.5–5.0	0.06	<0.01				<0.01	0.14	0.34	0.54	1.18
4.0–4.5	0.08	0.03	<0.01			0.02	0.26	0.47	0.86	2.03
3.5–4.0	0.19	0.08	0.03		<0.01	0.07	0.55	0.72	1.65	3.68
3.0–3.5	0.33	0.15	0.11	<0.01	0.01	0.24	1.03	1.12	3.00	6.68
2.5–3.0	0.62	0.28	0.24	0.01	0.04	0.52	1.66	1.68	5.05	11.73
2.0–2.5	1.18	0.63	0.55	0.09	0.19	0.93	2.39	2.66	8.62	20.35
1.5–2.0	2.50	1.47	1.10	0.30	0.44	1.51	3.59	4.22	15.13	35.48
1.0–1.5	5.38	2.57	2.00	0.79	0.87	1.95	4.64	5.78	23.97	59.45
0.5–1.0	7.29	3.44	2.46	1.54	1.43	1.87	4.29	6.30	28.62	88.07
0.0–0.5	3.08	1.64	0.75	0.25	0.17	0.19	2.61	3.24	11.93	

Mean Wave Direction [°T From]

Figure B-3: Near tie-in wave scatter [ref III]



All-Year

Current Speed at 0m [m/s]	N	NE	E	SE	S	SW	W	NW	Total %	Exceed %
Total	2.56	7.29	36.34	3.37	1.69	5.05	37.96	5.75	100.00	
			<0.01				<0.01		<0.01	
1.15		<0.01	<0.01				<0.01		<0.01	
1.10		<0.01	<0.01				<0.01		<0.01	
1.05		<0.01	<0.01				<0.01		<0.01	
1.00		<0.01	0.01				<0.01		0.02	0.01
0.95		<0.01	0.03				0.01		0.05	0.03
0.90		<0.01	0.10				0.01		0.12	0.08
0.85		<0.01	0.30	<0.01			0.04		0.35	0.20
0.80		0.02	0.88	<0.01		<0.01	0.17		1.07	0.55
0.75		0.03	2.13	<0.01		<0.01	0.90		3.06	1.62
0.70		0.07	3.46	<0.01		<0.01	2.49		6.02	4.69
0.65		0.12	4.19	<0.01		<0.01	4.07		8.39	10.71
0.60		0.21	4.41	<0.01		<0.01	4.79	<0.01	9.42	19.09
0.55		0.32	4.20	<0.01		0.03	4.91	<0.01	9.46	28.51
0.50		0.43	3.73	<0.01	<0.01	0.07	4.80	<0.01	9.04	37.98
0.45		0.53	3.23	<0.01	<0.01	0.20	4.34	0.04	8.35	47.01
0.40	<0.01	0.61	2.81	0.04	<0.01	0.36	3.73	0.16	7.70	55.36
0.35	<0.01	0.72	2.35	0.14	<0.01	0.56	2.97	0.39	7.13	63.07
0.30	0.04	0.84	1.85	0.36	<0.01	0.78	2.13	0.78	6.78	70.19
0.25	0.24	0.97	1.31	0.70	0.03	0.97	1.36	1.22	6.81	76.98
0.20	0.71	0.99	0.78	0.98	0.36	1.05	0.72	1.49	7.09	83.79
0.15	0.89	0.87	0.38	0.80	0.85	0.72	0.33	1.13	5.97	90.88
0.10	0.59	0.47	0.14	0.28	0.38	0.25	0.14	0.46	2.72	96.85
0.05	0.09	0.07	0.03	0.04	0.05	0.04	0.03	0.07	0.43	99.57
0.00										

Current Direction at 0m [°T Towards]

Figure B-4: Near tie-in current scatter [ref III]